Pasadena College of Chiropractic

VISCERAL INNERVATION

A concise, systematic presentation of the Autonomic Nervous System and its clinical application to the problems met in general practice.

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FOREWORD

No phase of neurology is so important to the general practitioner as that dealing with the autonomic nervous system. Since the greater number of patients seen by the average physician complain of disorders involving organs or systems innervated by this involuntary nervous system, it behooves the doctor to have a thorough and practical knowledge of this branch of neurology. This knowledge will form a bridge between physiological facts and clinical observations and will promote a broader understanding in the field of symptomatology by showing the physiological basis for a greater part of the symptoms met in disease. It will give new light on etiology and form a scientific basis upon which proper physiological treatment may be outlined.

It is the intended purpose of this monograph to provide the student or busy practitioner with a comprehensive review of the autonomic nervous system devoid of theoretical discussion and points which have no particular clinical value. It is intended that the information herein presented be thoroughly practical and usable so that this book may serve as a ready reference to provide a clearer understanding of the patient's complaints and a guide for the application of treatment. Part One presents an authoritative, concise review of the anatomical and physiological facts upon which a practical knowledge of the autonomic nervous system may be based. Part Two presents brief but comprehensive discussions of the innervation of the various organs giving not only the nerve supply and functions but also the clinical application. It is hoped that this section may be found worthy of use as a reference guide in daily practice.

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PART ONE

The understanding of the clinical phenomena seen in cases of autonomic imbalance depends upon a clear, basic knowledge of the structure and functions of the autonomic nervous system. The chapters in Part One of this monograph present these basic facts in addition to discussing disordered visceral function in the light of autonomic imbalance, describing the viscerosomatic reflexes commonly seen in visceral disease, and presenting some fundamental considerations concerning treatment in cases of autonomic imbalance. This material is written for busy people who want the major point of information without having to sift it from scores of pages of detailed discussions. The information presented on the following pages is briefly but concisely written and presents the important information on the subject as contained in the detailed writings of many modern authorities.

Chapter One

THE AUTONOMIC NERVOUS SYSTEM -- ITS STRUCTURE

A study of visceral innervation resolves itself into a study of the autonomic nervous system since it is this division of the nervous system which innervates the organs of the body. In order to fully comprehend the clinical aspects of visceral innervation, it is essential to have at least a general knowledge of the anatomy and physiology of the autonomic nervous system and thus these facts are presented briefly in the first chapters of this book.

Definition

To give a clear presentation of the autonomic nervous system through an anatomical description would be extremely difficult and such a description necessarily would be lengthy and complex. This is true because the autonomic nervous system is not an anatomical entity; it stands not as a separate anatomical unit, but rather it is closely bound and united with the cerebral-spinal system. It is more practical to consider the autonomic nervous system as a functional division of the nervous system concerned with the innervation of the involuntary muscles and glands of the body. The function then, rather than the anatomical units, distinguish the autonomic nervous system as a distinct division of the entire nervous system.

With function in mind then, the autonomic nervous system may be defined or best described as that functional division of the nervous system concerned with the innervation of all the smooth (involuntary) muscles, cardiac muscles and the glands of the body. The smooth muscles reached by autonomic fibers include those of the visceral organs, blood vessels and certain glandular structures and the pilomotor muscles. The glands innervated by this system include those of the endocrine system, the digestive glands, the glands of the mucous membranes, the salivary and lacrimal glands and the sweat glands of the skin. From the foregoing, it may be noted that the structures reached by the nerves of the autonomic system are those over which we have little or no voluntary control and hence this system of nerves is frequently referred to as the involuntary nervous system.

Confusion of Terminology

In fact, much confusion exists in the terms used to describe this portion of the nervous system not under the control of the will. Various writers have used the terms *involuntary*, *vegetive*, *sympathetic*, and *autonomic*. Because of this confusion of terms, it seems advisable to set forth that which is to be used in the following pages.

The term *autonomic* which means self-governing is the term sugested by Langley who further subdivides the autonomic system into the sympathetic and parasympathetic systems. The terminology as outlined by Langley is now more generally used and accepted in modern neurological discussions and consequently is used in this monograph.

THE SYMPATHETIC DIVISION OF THE AUTONOMIC NERVOUS SYSTEM

The sympathetic or thoraco-lumbar division of the autonomic nervous system consists of the nerve fibers which arise from nerve cell bodies located in the lateral cell columns of the gray matter of the spinal cord in all the thoracic and the first three or four lumbar segments. It further includes the post-ganglionic fibers with which they synapse and the plexuses and ganglia formed in their pathways.

A typical sympathetic pathway is shown in Figure 1. Langley has shown that there are always two neurons in a visceral efferent (outgoing) pathway serving to conduct an impulse from the central nervous system to the smooth muscle or glandular tissue. The neuron of the first order in this series is designated as the preganglionic neuron and in the sympathetic division has its cell body located in the lateral cell column of the gray matter of the cord. From the cell body, the nerve fiber extends forward and emerges from the spinal cord as a part of the ventral root of the spinal nerve, passes through the intervertebral foramen with the spinal nerve proper and then branches from the anterior primary division of the spinal nerve as the white ramus through which it passes to reach the sympathetic ganglionated chain or trunk (Fig. 2).

The Sympathetic Ganglionated Chains

The ganglionated chains frequently are referred to as the *sympathetic trunk* or the *lateral ganglia* in controdistinction to the collateral ganglia located farther from the center (such as the celiac ganglion) and the terminal ganglia located in relation to the structure to be innervated. The ganglionated chains are two in number located, one on each side, on the antero-lateral aspect of the vertebral column. A single chain usually consists of two or three cervical ganglia, ten to twelve thoracic ganglia, one to three lumbar ganglia, one to three sacral ganglia and the single ganglion impar which is formed by the union of the two chains at their lower ends. Each of the ganglia just mentioned are connected by nerve fibers with the ganglion above and below and thus the structure is referred to as a chain.

The preganglionic fiber, upon reaching the chain, may terminate there or may extend on through the chain to terminate in a collateral ganglion. At its termination in either a lateral or collateral ganglion, the preganglionic fiber synapses with the neuron of the second order designated as the postganglionic fiber which extends to the structure to be innervated.

The Gray Rami

Extending from the ganglia of the chain to all spinal nerves are bundles of nerve fibers known as gray rami.

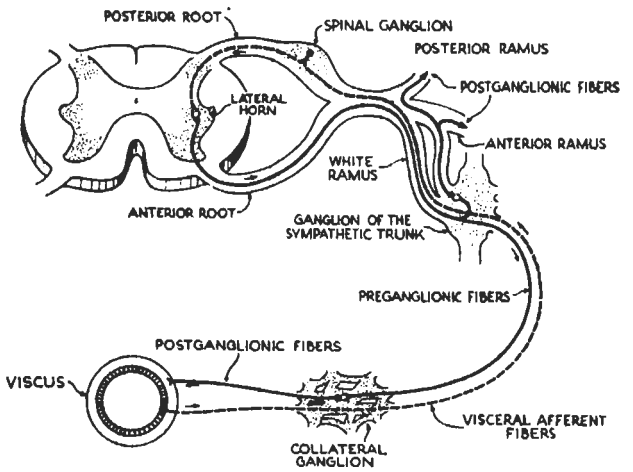


Fig. 1—A TYPICAL SYMPATHETIC PATHWAY

These bundles are composed of postganglionic sympathetic fibers whose cell bodies are located in the ganglia of the chain. The fibers, after joining the spinal nerves, are distributed with them as vasomotor, pilomotor and secretory fibers to blood vessels, smooth muscles of the hair follicles and to the sweat glands in the areas innervated by the respective spinal nerve (Fig. 3). While white rami extend between only the thoracic and upper lumbar spinal nerves and the ganglia of the chain, gray rami extend from the ganglia of the chain to all the spinal nerves; thus, every spinal nerve carries sympathetic fibers with it in its distribution. The gray rami which extend from the cervical ganglia of the sympathetic ganglionated chain to join the cervical spinal nerves are composed of postganglionic fibers which have synapsed with preganglionic fibers having their origin in the upper thoracic segments of the spinal cord (Fig. 4). This explains the practical importance of giving attention to the upper thoracic region in disorders involving structures innervated by cervical nerves. Similarly, the gray rami which extend from the lower lumbar and sacral ganglia and the ganglion impar of the ganglionic chain to join the lower lumbar, sacral and coccygeal nerves respectively are composed of postganglionic fibers which have synapsed with preganglionic fibers having their origin in the eleventh and twelfth thoracic and the first three or four lumbar segments of the spinal cord. Herein lies the practical importance of treating the lower thoracic and upper lumbar regions in conditions, particularly those showing circulatory disturbances, in the areas supplied by lower lumbar, sacral and coccygeal nerves.

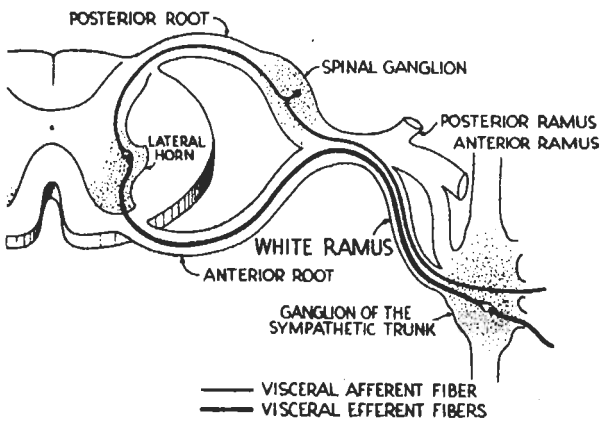


Fig. 2—THE WHITE RAMUS

White rami are short bundles of fibers which unite the thoracic and upper four lumbar nerves with corresponding ganglia of the sympathetic trunks. They consist of visceral afferent and preganglionic efferent (sympathetic) fibers.

Distribution of the Sympathetic Fibers

Since sympathetic fibers arising from several spinal segments have a similar distribution and function, a study of the distribution of the sympathetic fibers may be approached most easily from the standpoint of these units.

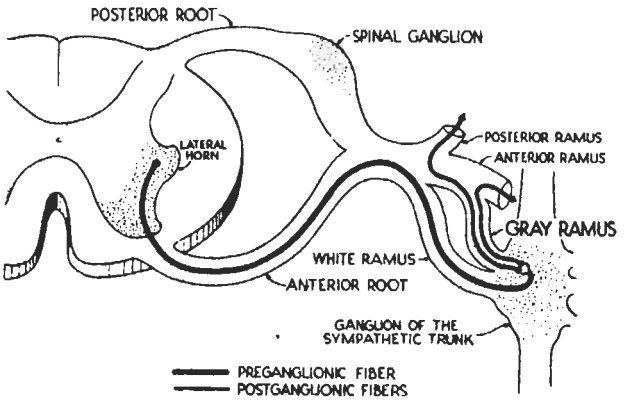


Fig. 3—THE GRAY RAMUS

Gray rami are short bundles of unmyelinated fibers which unite the ganglia of the sympathetic trunk with all spinal nerves. They consist of postganglionic sympathetic fibers whose cell bodies are located in the ganglia of the sympathetic trunk. The fibers, after joining the spinal nerves, are distributed with them as vasomotor, pilomotor and secretory fibers to blood vessels, smooth muscles of the hair follicles, and sweat glands in the areas innervated by the respective spinal nerve.

It may be stated broadly that impulses traveling over sympathetic fibers arising from the first four or five thoracic segments influence every tissue in the head, neck and thorax. Specifically, these nerves carry impulses which ultimately influence the blood vessels, glands or smooth muscles in—

the skin of the head, neck, shoulders and upper part of the thorax
the muscles of the head, neck, shoulders and upper part of the thorax
the eyes
the ears
the brain
the pineal and pituitary glands
the lacrimal glands
the salivary glands

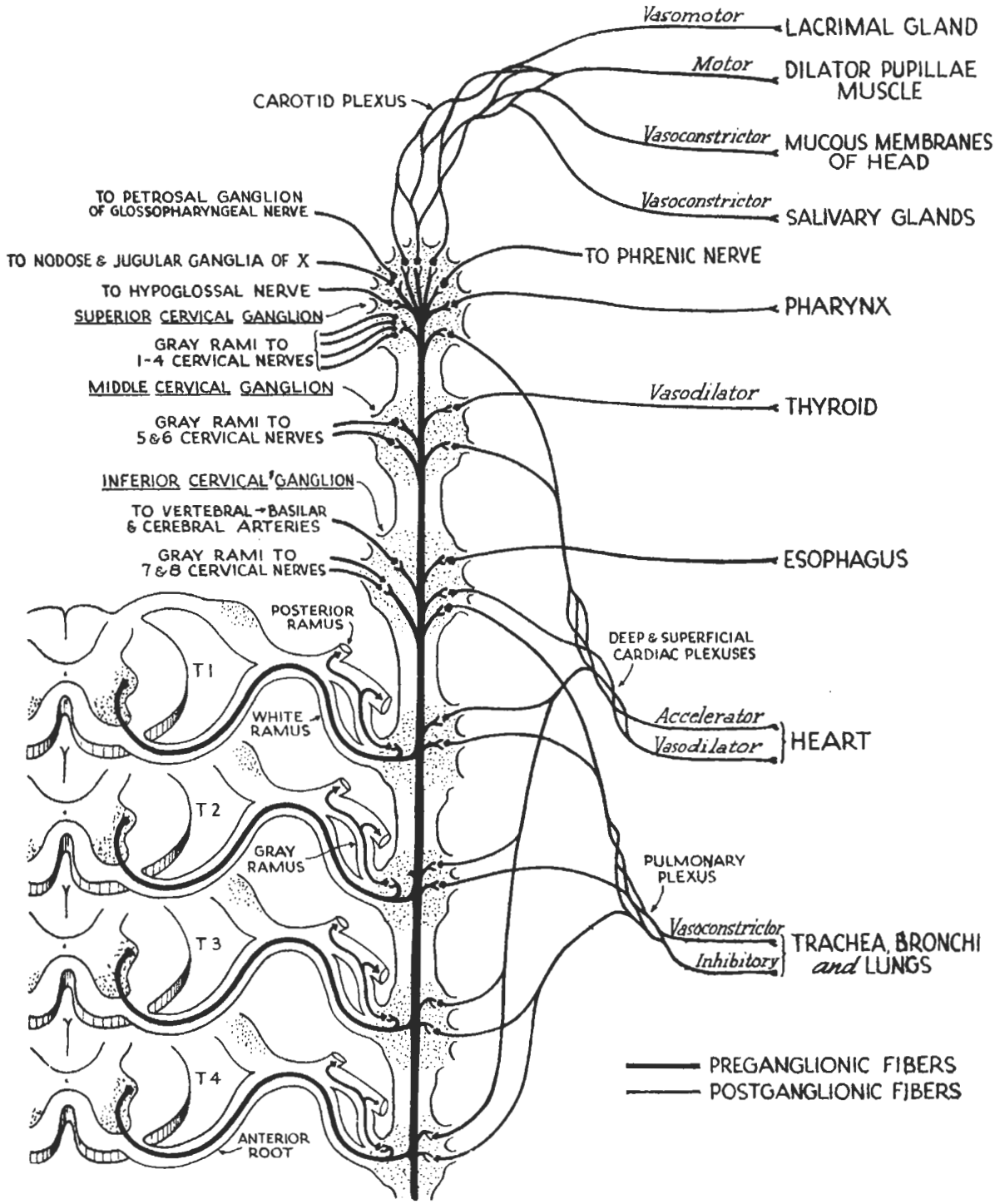


Figure 4

DISTRIBUTION OF THE SYMPATHETIC FIBERS ORIGINATING IN FIRST TO FOURTH THORACIC SEGMENTS OF THE SPINAL CORD

the teeth
the mucous membrane lining the nasal cavity, sinuses, mouth, pharynx and larynx
the tonsils
the thyroid and parathyroid glands
the trachea
the bronchi
the lungs
the visceral layer of the pleura
the upper part of the parietal layer of the pleura
the esophagus
the heart and pericardium

The sympathetic fibers arising from the fifth, sixth, seventh, eighth and ninth thoracic segments ultimately influence the blood vessels, glands, and smooth muscles in—

the arm, forearm and hand
the lower part of the parietal layer of the pleura
the cardiac sphincter
the stomach
the pyloric sphincter
the small intestine (proximal half or more)
the pancreas
the liver
the gall bladder and related ducts
the spleen
the adrenal glands
the large blood vessels of the abdomen
the skin of the lower part of the thorax and upper part of the abdomen
the thoracic and abdominal muscles

The sympathetic fibers arising from the ninth, tenth, eleventh and twelfth thoracic segments ultimately influence the blood vessels, glands and smooth muscles in—

the distal portion of the small intestine
the proximal half of the colon
the kidneys
the ureters
the ovaries or testes
the uterus and Fallopian tubes or the prostate gland
the large blood vessels of the abdomen
the vagina
the vas deferens
the seminal vesicles
the skin of the abdomen and lumbar region
the muscles of the abdomen

The sympathetic fibers arising from the first three or four lumbar segments ultimately influence the blood vessels, glands and smooth muscles in—

the skin of the buttocks, thighs, legs, and feet
the muscles of the lower extremities
the distal half of the colon
the rectum
the internal anal sphincter
the urinary bladder
the urethra
the uterus and Fallopian tubes or the prostate gland
the vas deferens
the seminal vesicles
the vagina

THE PARASYMPATHETIC DIVISION OF THE AUTONOMIC NERVOUS SYSTEM

The parasympathetic nervous system is divided anatomically into a *cranial and sacral division* (Fig. 8). In spite of the anatomical separation of the two divisions, they are classified together because of the harmonious function between the two—one complementing the other and both antagonizing the sympathetic in those organs reached by both the sympathetic and parasympathetic fibers.

The Cranial Division

Parasympathetic fibers included in the cranial portion arise from nuclei in the brain stem (mid-brain, pons and medulla) and course with the third, seventh, ninth and tenth cranial nerves. The parasympathetic fibers of the third cranial (oculomotor) nerves transmit impulses which, after relaying in the ciliary ganglia reach the ciliary muscles of the eye and also the sphincter muscles of the pupil. The parasympathetic fibers in the seventh cranial (facial) nerves transmit impulses which relay in the sphenopalatine ganglia and ultimately reach the lacrimal glands and the glands and the blood vessels of the mucous membranes of the nasal cavities, sinuses and palate. Other impulses carried in the seventh cranial nerve relay in the submaxillary ganglia and reach the submaxillary and sublingual salivary glands. Impulses transmitted by the parasympathetic fibers in the ninth cranial (glossopharyngeal) nerves relay in the otic ganglia and eventually reach the parotid glands. The parasympathetic fibers of the tenth cranial (vagus) nerves transmit impulses which influence the muscles and glands in the trachea, bronchi, heart, esophagus, stomach, small intestine, proximal half of the colon, liver, gall bladder and pancreas.

The Sacral Division

The sacral parasympathetic fibers arise from cell bodies located in the lateral portion of the gray matter of the second, third and probably the fourth sacral segments of the spinal cord. From their cells of origin, these parasympathetic fibers emerge from the cord with the ventral roots of the respective sacral nerves and after passing through the sacral foramina, branch from the sacral nerves as visceral rami which are distributed mainly to the pelvic organs. Specifically, the impulses carried by these fibers ultimately reach the urinary bladder, penis, clitoris, cervix of the uterus, prostate gland, the distal half of the colon and the rectum.

THE VISCERAL AFFERENT NERVES

In addition to the visceral efferent (outgoing) nerves referred to as the components of the autonomic nervous system, there are afferent (incoming) nerves from most of the visceral structures which carry impulses from the organs to the brain or spinal cord. These nerves should not be referred to as sensory nerves because their impulses ordinarily do not reach conscious levels. Their chief function is to initiate motor and secretory impulses to be sent forth to activate the organs from whence the afferent impulses came. Most authoritative writers generally do not include the afferent visceral fibers as a part of the autono-

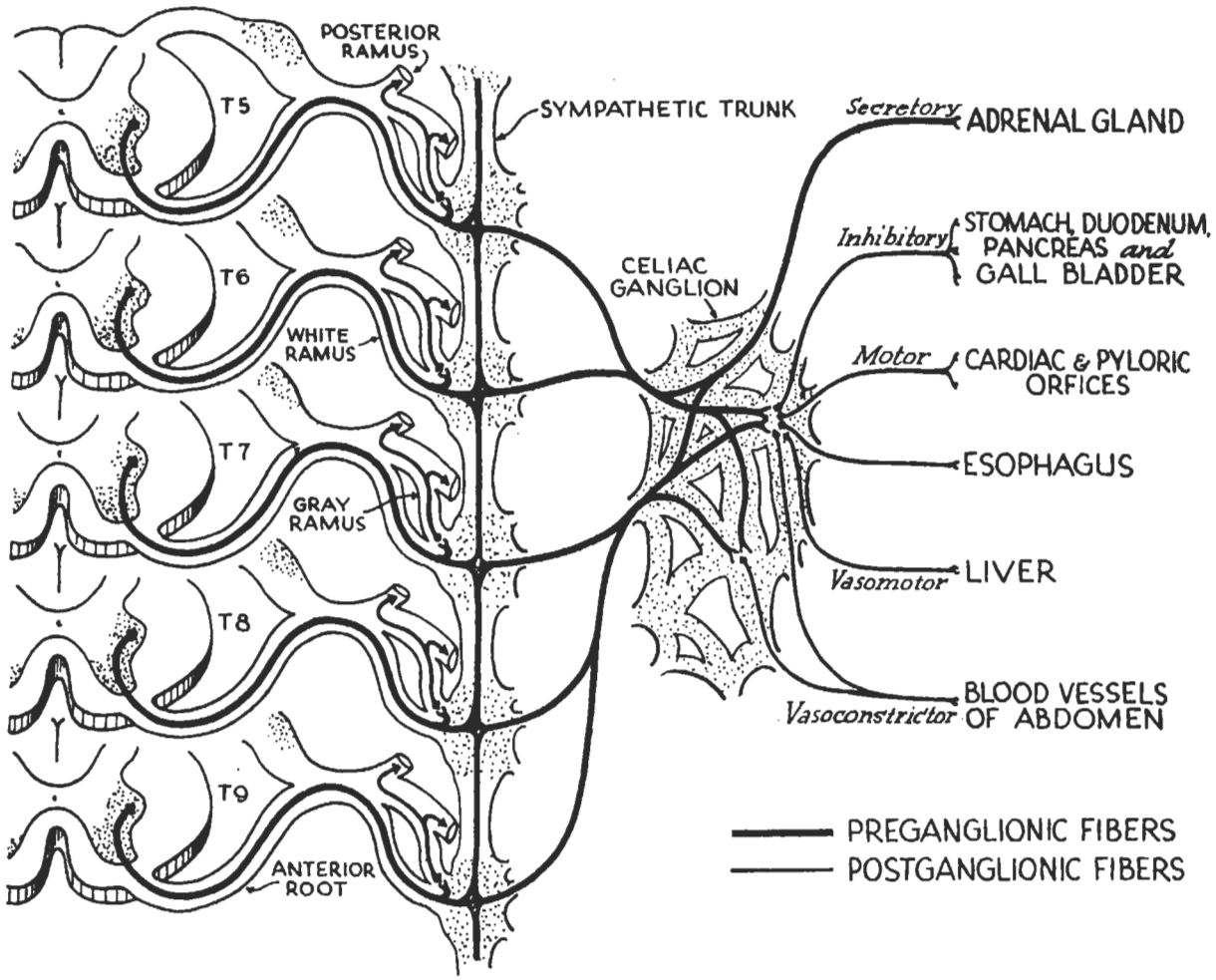


Figure 5

DISTRIBUTION OF THE SYMPATHETIC FIBERS ORIGINATING IN FIFTH TO NINTH THORACIC SEGMENTS OF THE SPINAL CORD

mic nervous system. However, in considering the clinical aspects of visceral innervation, the afferent pathways cannot be omitted because it is their impulses which initiate the reflexes which create most of the symptoms and signs commonly found in visceral disease.

Just as most visceral organs receive two sets of efferent nerves (sympathetic and parasympathetic) so do most of them have a dual afferent supply which corresponds to their efferent supply. Thus, we may consider one set of the visceral afferent fibers as associated with the sympathetic system and the other set as associated with the parasympathetic system.

The afferent visceral fibers associated with the sympathetic system carry impulses inward to the center from the structures reached by the sympathetic nerves. These fibers are found along with the sympathetic fibers and consequently the afferent fibers are carried to the same segments of the spinal cord from whence the sympathetic fibers have taken their origin. The pathway of a typical visceral afferent fiber is shown in Fig. 1.

The structures in the head which receive parasympathetic fibers from cranial origin have a true sensory supply. The sensory impulses from these structures are carried over the sensory fibers of the fifth cranial (trigeminal) nerves. Although these fibers do not belong to the visceral system, they are clinically important in cases of pathology involving these head structures because of the reflexes which they initiate.

Most of the organs reached by the parasympathetic fibers of the vagus send afferent impulses to the center via the visceral afferent fibers of the vagus. The pathway of the afferent fibers correspond closely to those of the efferent. The pelvic structures reached by the sacral parasympathetic fibers likewise send impulses back to the sacral segments via the sacral visceral afferent nerves.

The clinical importance of the visceral afferent nerves and the abnormal reflexes they may initiate in visceral disease is discussed in the chapter dealing with reflex symptomatology.

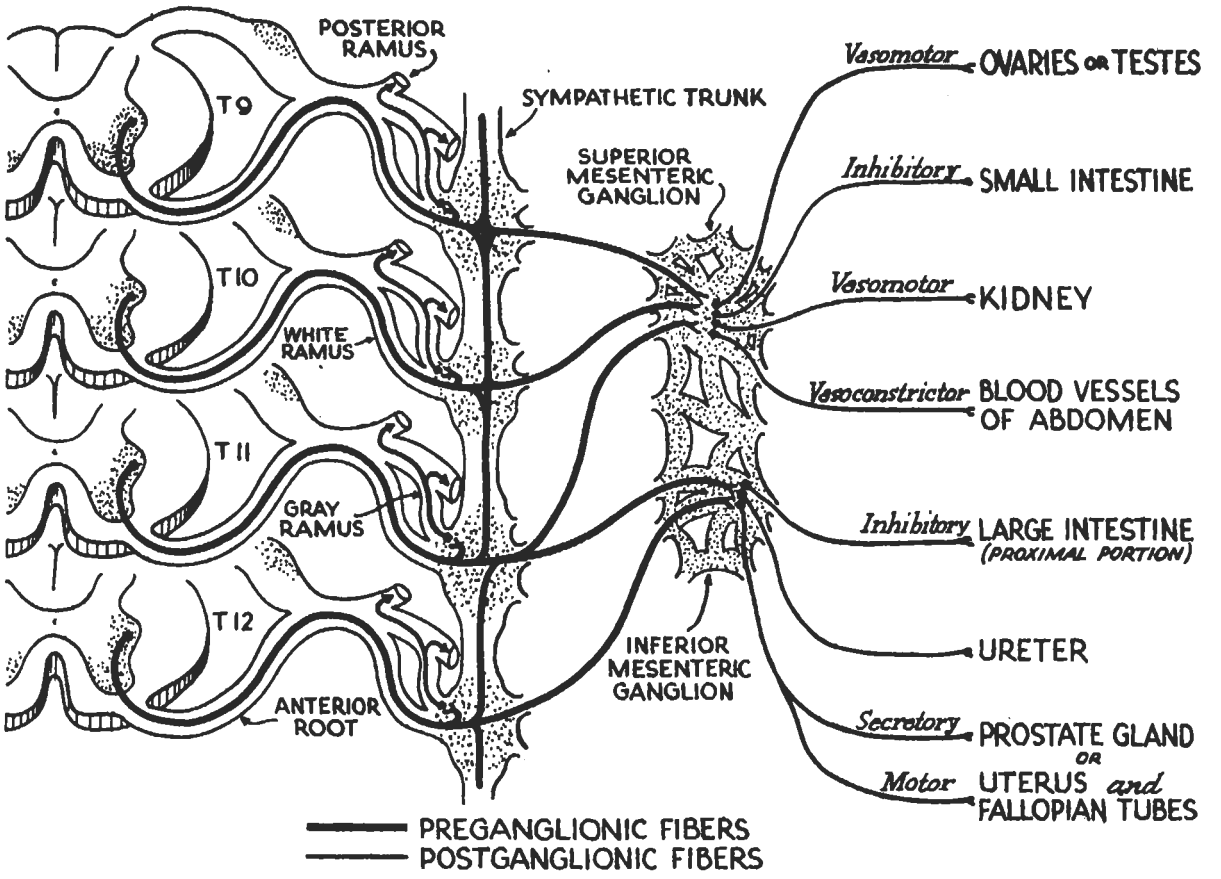


Figure 6

DISTRIBUTION OF THE SYMPATHETIC FIBERS ORIGINATING IN NINTH TO TWELFTH THORACIC SEGMENTS OF THE SPINAL CORD

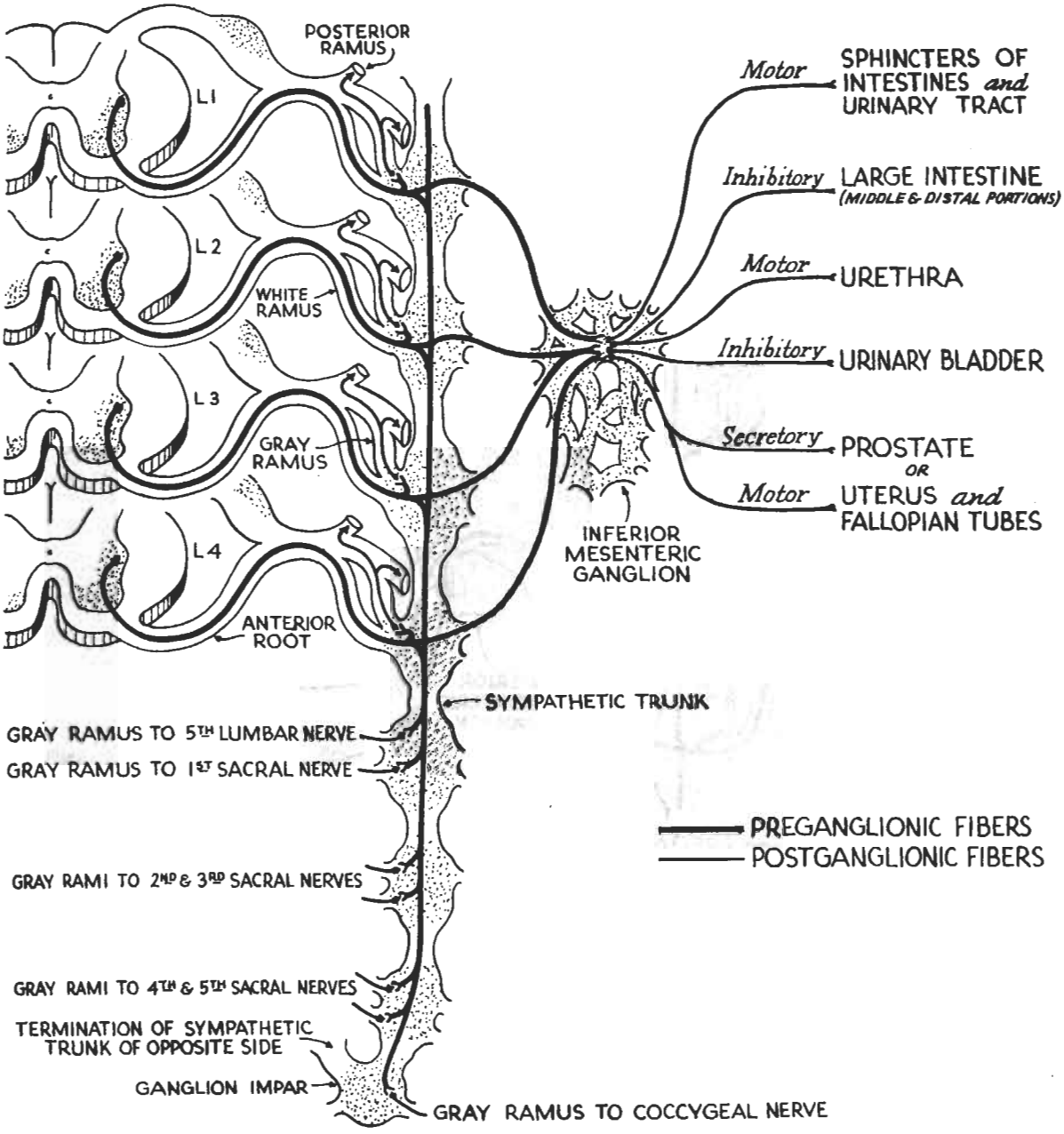


Figure 7

DISTRIBUTION OF THE SYMPATHETIC FIBERS ORIGINATING IN FIRST TO FOURTH LUMBAR SEGMENTS OF THE SPINAL CORD

Chapter Two

THE AUTONOMIC NERVOUS SYSTEM -- ITS FUNCTIONS

Broadly speaking, the autonomic nervous system acts to control all the vital functions of the body through maintaining and controlling the circulation, respiration, digestion, assimilation, elimination and the many other acts essential to life. The autonomic nervous system acts further to coordinate and integrate these functions and to adapt the individual to his environment. The adaptation of the circulation in response to changes in temperature, the increase in the secretion of adrenalin under the stimulus of fear, the flow of salivary secretions upon the sight or smell of food, the contraction of the pupil in the presence of a bright light, and a multitude of other reflexes are examples of the methods by which the nervous system acts to adapt the individual to his changing environment and the constant changes taking place within his body.

The Reflex Arc is the Unit of Function

Just as the individual neuron is the unit of structure of the nervous system, so is the reflex arc the unit of function. The life processes are a chain of reflex actions. All efferent nerve impulses which go forth from the brain or spinal cord to some peripheral point are initiated by and in response to some stimulus. The stimulus may be a result of psychic activity (either conscious or subconscious) or more often the stimulus may be in the form of afferent nerve impulses brought into the brain or spinal cord from a peripheral point as a result of chemical, mechanical, thermal or photic stimulation of the endings of the afferent nerves. Nearly all the vital functions are a result of reflex action. The following examples may further clarify this statement.

The presence of food in the stomach acts to stimulate the nerve endings in the stomach wall with the result that impulses are initiated which pass to the medulla over the visceral afferent fibers of the vagus nerves. Upon reaching the medulla, these impulses reflexly initiate motor and secretory impulses which then are carried back to the muscles and glands of the stomach via the visceral efferent (parasympathetic) fibers of the vagus nerves and thus activate the gastric digestive functions. In addition, there are local reflexes through the myenteric and submucous plexuses.

Other reflexes are widespread in their effects. Changes in the pressure and the chemical condition of the blood affect nerve endings in the arch of the aorta to initiate afferent nerve impulses which are transmitted to the medulla via the vagus nerves; these impulses then reflexly regulate blood pressure, heart rate and rhythm, adrenal secretion and pulmonary ventilation.

Still other examples of highly important reflexes could be given. Some of the reflexes are simple in their nature while others are extremely complex, involving many neurons and touching many nuclei or centers within the brain or spinal cord. Study of them can only impress us with the fact that nearly every functional activity within the body in some way is dependent upon nerve reflexes for their activation. The greater number of visceral disorders at least in part are due to a disturbance in the normal reflexes.

ANTAGONISTIC ACTIONS OF THE SYMPATHETIC AND PARASYMPATHETIC SYSTEMS

It already has been pointed out that most organs are innervated by both sympathetic and parasympathetic nerves; when this is true, the actions or influences of the impulses of the two divisions are antagonistic. Hence, when sympathetic impulses stimulate a certain function, the parasympathetic impulses inhibit that same function and vice versa. The normal functions within the organs are maintained by a balance in the innervation from these two divisions of the autonomic nervous system. So that the antagonistic actions may be discerned and compared more easily, the actions of the sympathetic and parasympathetic impulses upon the various organs have been placed in tabular form and may be found at the end of this chapter. A more detailed discussion of the anatomical and physiological aspects of the innervation of the organs is given in Part Two of this book which deals with the innervation under the headings of the respective organs.

It should be mentioned at this point that the sympathetic and parasympathetic impulses do not entirely control the functions of the organs, but rather, they should be thought of as exerting a regulatory control. It has been demonstrated that many of the visceral organs will continue to function after all the extrinsic nerves have been severed; at first, the functions are irregular but in time an equilibrium is established which closely approaches the normal. This phenomena is due to the endocrine influences and to the activity of the intrinsic nerve supply existing in several of the organs. In the absence of the extrinsic nerves to the organs however, there is a loss of the normal responses which adapt the body to changes in environment, etc. These facts may imply that the autonomic nervous system is of rather minor importance in relation to the function of the organs. This is not true however, because it has been demonstrated further that so long as the extrinsic nerves are intact and do exert their influence, any disturbance in the normal equilibrium of the sympathetic and parasympathetic systems is productive of disordered function.

GENERAL PURPOSES OF THE SYMPATHETIC AND PARASYMPATHETIC SYSTEMS

The sympathetic and parasympathetic nervous systems have general physiological functions to perform in the

body. The process of committing to memory all the various individual actions will be greatly simplified by recognizing the fact that all the actions of the sympathetics (or parasympathetics) are of a nature as to bring about certain specific and basic actions in the body as a whole. It will be noted that the sympathetic system reacts to such conditions as fear, anger, rage, pain, shock, infections and injury by correlating and stimulating the body functions which prepare the individual for fight or flight or control the metabolic and protective functions. On the other hand, the parasympathetic system provides for the sustenance of the body by correlating the processes for the object of digestion, absorption and the elimination of the wastes of the body and by regulating the respiration.

The General Purposes of the Sympathetic System

When an individual meets with conditions which evoke either fear or anger, the sympathetic system becomes markedly stimulated to mobilize the body for either defense or flight. In order to so prepare the body, the pupils dilate, the blood vessels of the alimentary canal constrict with a corresponding dilatation of the vessels in the skeletal muscles to provide these muscles with the blood needed for their activity, the rate and force of contraction of the heart and the blood pressure are increased to fulfill the need in muscular activity, glycogen is converted into glucose and is thrown into the blood stream to supply a ready energy, the adrenal and thyroid glands are stimulated with a consequent increase in the metabolic rate, and pulmonary ventilation is increased to provide the blood with a greater amount of oxygen. The activities just enumerated are a result of sympathetic stimulation aroused through psychic channels when an individual is confronted with conditions evoking fear or anger.

The toxins of any acute infectious process stimulate the sympathetic nervous system and in so doing arouse the non-specific defensive functions of the body. The symptom-complex seen in nearly all acute infections is due largely to the actions resulting from sympathetic stimulation. These well known symptoms include the rapid pulse, decreased motor and secretory activities of the gastro-intestinal tract shown as a loss of appetite and constipation, adrenal and thyroid stimulation causing increased metabolic functions and dry skin with lessened elimination resulting in a rise of temperature.

The General Purposes of the Parasympathetic System

In the absence of factors producing sympathetic stimulation, the taking of food stimulates and correlates those functions concerned with the digestion and absorption of the food and the elimination of the wastes. Specifically, the salivary secretions are increased, the motor and secretory functions of the gastro-intestinal tract are activated, the flow of the digestive fluids from the pancreas are stimulated, the gall bladder contracts expressing the stored bile into the duodenum, and the abdominal blood vessels are dilated to facilitate the absorption of the digested foods and to supply the gastro-intestinal muscles and glands with an increased blood supply needed for their greater activity.

In a general sense, the functions of the parasympathetic system may be thought of as those which provide the nourishment and energy for the body and the elimination of the wastes while the sympathetic functions regulate the actual utilization of the absorbed food materials.

THE RELATION OF THE ENDOCRINE GLANDS TO THE AUTONOMIC NERVOUS SYSTEM

The relationships between certain endocrine glands and the autonomic nervous system are briefly summarized in the following points:

1. The medullary portion of the adrenal glands through the secretion of adrenalin, stimulate the sympathetic system and may be important in maintaining the normal tonus or activity of the sympathetic nerves. Conversely, stimulation of the sympathetic fibers to the adrenals causes an increased secretion of adrenalin.

2. The thyroid gland by its secretion of thyroxin stimulates the sympathetic nerves to the eye in particular and the entire sympathetic system in general. Likewise, sympathetic impulses to the thyroid stimulate its secretion.

3. The secretion of the posterior lobe of the pituitary gland may act upon the autonomic centers in the diencephalon according to some physiologists.

4. The anterior pituitary secretion seems to cooperate to some extent with the sympathetic system by hormonically stimulating other ductless glands which the sympathetic impulses presumably also activate. Among these are the islets of Langerhans of the pancreas, the thyroid, ovaries and testes.

5. Other glands seem to be parasympatheticotropic among them being the parathyroids and the duodenal glands which manufacture secretin.

CHART OF THE PHYSIOLOGICAL ACTIONS OF THE AUTONOMIC NERVOUS SYSTEM

	SYMPATHETIC	*PARASYMPATHETIC*
Eye	Dilates pupil	Constricts pupil Facilitates accommodation
Lacrimal glands	Constricts blood vessels Inhibits secretion	Stimulates secretion
Mucous membranes of the head	Constricts blood vessels Inhibits secretion	Dilates blood vessels Stimulates secretion
Salivary glands	Increases the secretion of organic substances of the saliva and possibly constricts blood vessels	Increases the secretion of the watery elements of the saliva and possibly dilates the blood vessels
Thyroid gland	Vasomotor Increases secretion	Decreases secretion (?)
Heart	Accelerates heart rate, augments force of contraction and possibly dilates coronary arteries	Decreases rate, conductivity and force of contraction and constricts coronary arteries
Bronchi	Constricts blood vessels Inhibits secretion Relaxes bronchial muscles	Contracts bronchial muscles Increases secretion
Esophagus	Vasomotor	Contracts
Cardiac orifice	Vasomotor	Constricts and relaxes
Stomach	Constricts blood vessels Inhibits gastric motility Decreases secretion of HCl	Increases gastric motility Stimulates secretion of HCl
Pyloric orifice	Contracts	Relaxes
Small intestine	Contricts blood vessels Inhibits peristalsis Decreases secretion	Stimulates peristalsis Increases secretion
Colon and rectum	Constricts blood vessels Inhibits peristalsis Decreases secretion Constricts anal sphincter	Stimulates peristalsis Increases secretion Relaxes anal sphincter
Pancreas	Inhibits secretion of pancreatic juice	Increases secretion of pancreatic juice
Spleen	Vasomotor Contracts smooth muscles of capsule and trabecula	Unknown
Liver	Vasomotor Converts glycogen into glucose, increases protein metabolism in liver, inhibits cholesterol secretion in the bile	Inhibits protein metabolism in the liver and increases cholesterol secretion in the bile
Gall bladder	Relaxes muscles of gall bladder and constricts sphincters of bile ducts	Contracts muscles of gall bladder wall
Adrenal gland	Vasomotor Increases secretion of adrenalin	
Kidney	Vasomotor	Unknown
Urinary bladder	Contracts muscles of trigone and sphincter Relaxes muscles of bladder wall	Relaxes muscles of trigone and sphincter Contracts muscles of bladder wall
Ovaries or testes	Vasomotor	
Fallopian tubes and uterus	Stimulates contraction of muscles of tubes and uterus	Probably activates cervix and inhibits contraction of body of uterus
Prostate gland	Vasomotor	Contracts muscles within gland
Penis and clitoris	Vasomotor	Causes erection

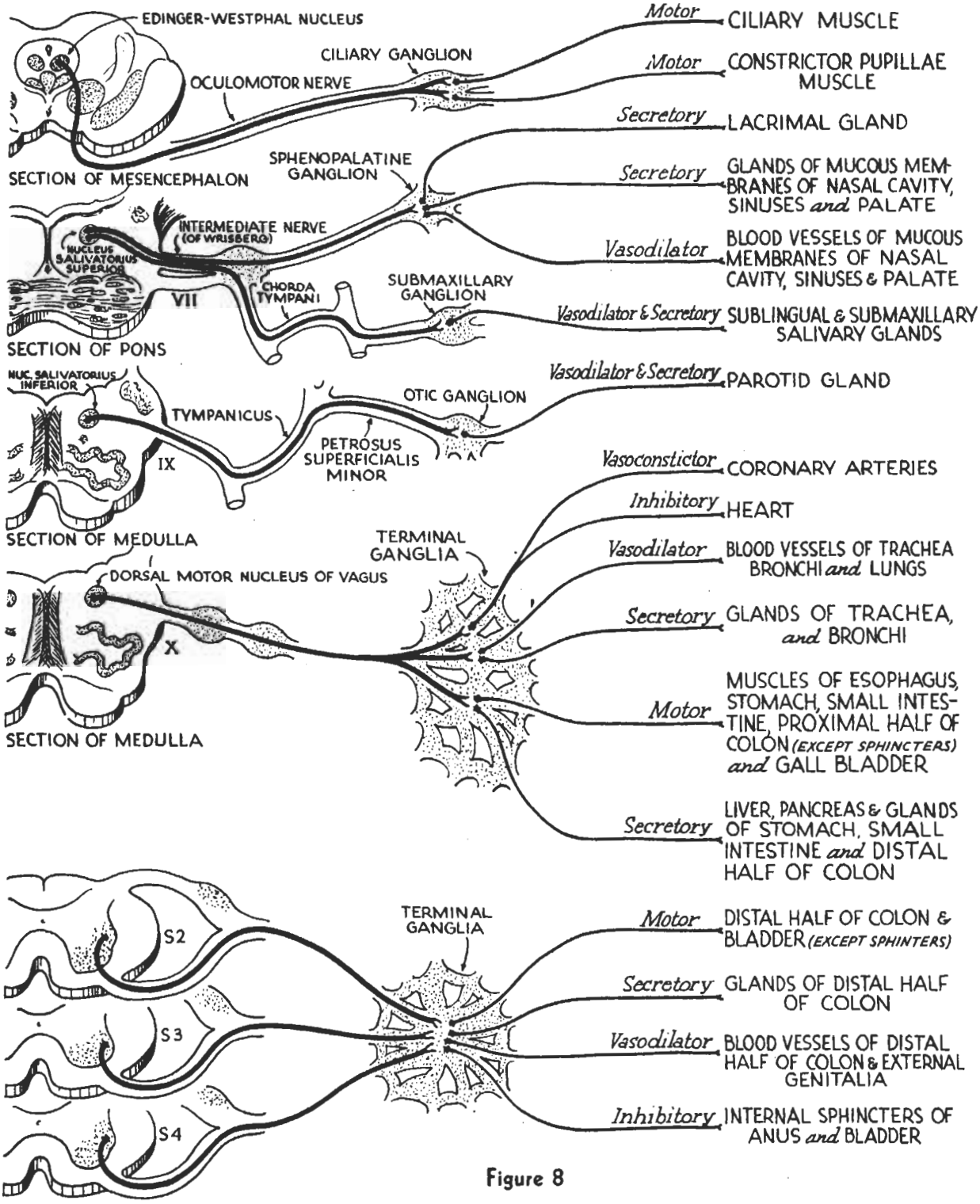


Figure 8

THE PARASYMPATHETIC NERVOUS SYSTEM

Chapter Three

THE CLINICAL SIGNIFICANCE OF AUTONOMIC IMBALANCE

Since nearly all the visceral organs are innervated through both the sympathetic and parasympathetic divisions of the autonomic nervous system which are functionally antagonistic, any disturbance in the balanced activity of the two divisions may result in disturbances of the visceral functions. Normally, the two divisions are tonically stimulated to maintain a physiological balance but this balance may be shifted in favor of one or the other of the divisions and thus inevitably create disorders of visceral function.

Sympatheticotonia and Vagotonia

The fact that an imbalance between the two autonomic divisions may underlie a large portion of visceral disorders was conceived several decades ago. It was recognized then, as it is now, that even individuals in an average state of health often show a slight predominace of sympathetic or of parasympathetic activity or that one individual was more responsive to slight sympathetic stimulation than to fairly strong parasympathetic stimulation or vice versa, showing that the one division of the autonomic system was more tonically stimulated and thus presented at least a potential imbalance of clinical significance. These observations gave rise to the classification of patients as being sympatheticotonic or parasympatheticotonic (more commonly called vagotonic) depending upon which division presented the real or potential predominance.

From the standpoint of neurological imbalance, the activity of an organ or the body functions in general may be disturbed in favor of either the sympathetic or parasympathetic nervous system. Consequently, it is possible to classify the various visceral disorders into one of two groups: (1) those resulting from predominating sympathetic activity, or (2) those resulting from predominating parasympathetic activity. The imbalance may be localized to one organ or one system or, at times, may involve the body functions generally so that the individual may be classified as being either sympatheticotonic or vagotonic. It should be recognized at this point, however, that a relative sympatheticotonia (either local or general) may exist in the absence of exaggerated sympathetic tonus when there is a subnormal tonus of the corresponding parasympathetic nerves. This also applies in the case of a relative vagotonia when there is a subnormal tonus of the corresponding sympathetic nerves.

Many writers have outlined a rather definite symptom-complex associated with the classical states of sympatheticotonia and vagotonia. The symptoms and signs associated with an exaggerated sympathetic tonus include dilatation of the pupil, protrusion of the eyeball, decreased lacrimal secretion, deficient salivary secretion, dryness of the mucous membranes, hyperthyroidism, tachycardia, dilatation of the stomach, hypomotility of the stomach and intestines, hyposecretion of the gastric and intestinal glands and of the pancreas, and the atonic type of constipation. The symptoms and signs associated with exaggerated parasympathetic tonus include epiphora, contraction of the pupil, increased secretion from the mucous membranes as in catarrh and hay fever, hoarseness, excessive salivary secretion, asthmatic symptoms, bradycardia, hypersecretion of the gastric and intestinal glands causing hyperchlorhydria, hypermotility of the stomach and intestines showing as diarrhea or spastic constipation, and irritable bladder.

CLASSIFICATION OF PATIENTS

It is often advantageous to classify patients as being either sympatheticotonic or vagotonic. The value in such classification lies in using it as a guide for therapeutic applications, in determining the characteristics of the patients and in forming an opinion as to the expected responses of the patient to treatment.

Sympatheticotonic Patients

Sympatheticotonic individuals have characteristics which generally enable one to identify them rather easily. They usually are tall and thin although the height may be altered from the characteristic by previous malnutrition or because of family traits. They generally are active and become impatient if work is not accomplished with the speed which they like. Their actions and speech are usually fast and sometimes impulsive. In their intense desire to accomplish the work at hand, they drive themselves often to their own detriment. Their mentality is usually sharp. Their impatience and their dislike to remain quiet and relaxed usually classifies these persons as nervous. The greater the exaggeration of the sympathetic activity, the greater and more pronounced these characteristics become.

Because of their refusal to rest more and to "slow down," the sympatheticotonic individuals always are in danger of exhausting the sympathetic nervous system and the related synergistic endocrine glands. As a result, when these individuals finally reach the doctor's office as patients, they often are suffering from such exhaustion as shown in indigestion, low blood pressure, asthenia, nervous breakdown, neurasthenia or collapse. The treatment should include rest, a new mental outlook, plain but attractive food well masticated, avoidance of all excitement and worry, and the abstinence from sexual relations. These patients generally are difficult to control, however, because they crave excitement and action. Even when they do resolve themselves to physical rest, their minds and imagination are usually far too active and fired with ambition to gain the maximum benefit from physical rest.

In spite of the fact that the sympatheticotonic individuals often are referred to as weak and sickly in appearance, they have a powerful defensive mechanism against infections and disease. The defensive functions respond quickly upon the

introduction of toxic or infective agents so that the temperature may rise on slight provocation and may go very high during acute infections. Such patients generally get over their illnesses quickly but are slow in recuperating due to the sympathetic depletion. Sometimes the sympathetics and the related glands may become exhausted during an acute illness and thus the defensive functions weaken and the condition may become chronic.

Because of the nature of the autonomic imbalance, sympatheticotonic persons are particularly apt to suffer from dry catarrh of the sinuses and nasal passages, the salivary secretions are apt to be poor in quantity and quality, the heart rapid or rapid upon the slightest exertion, and the stomach and intestines underactive with resulting poor digestion and constipation.

Neurologically, sympatheticotonic patients should have stimulative treatment in the cervical, lower lumbar and sacral regions and sedative treatment in the thoracic and upper lumbar regions. It usually will be found that such patients like treatments on the neck and in the lower lumbar and sacral regions and since such treatments stimulate the parasympathetic system and thus aid in neutralizing the overactivity of the sympathetics, they generally feel better. On the other hand, stimulative treatments in the thoracic region generally make them feel worse. This is not to be interpreted as advising against the correction of specific spinal lesions in the thoracic and upper lumbar regions of these patients. Such lesions in these regions very possibly may be causing stimulation of the thoraco-lumbar sympathetic nerves. It would seem advisable in such patients, however, to correct the specific lesions if they exist and then to give the thoracic and upper lumbar regions no further treatment that may give stimulation.

Vagotonic Patients

Vagotonic individuals frequently are classified as the anabolic type because of their tendency to build up and carry excessive fat. They usually are lovers of good food and consider eating as one of the chief joys of life. This, along with a lower rate of metabolism and slower habits of living, generally gives them bodies of middle stature well covered with fat. They like the luxuries and comforts of life and usually are slow in their movements and activities. Vagotonic persons generally benefit by exercise because exercise stimulates the sympathetic nervous system. However, they usually dislike exercise and consequently, if exercise is taken, it usually is in the form of a game.

Individuals who present a vagotonia are more apt to suffer from catarrhal conditions, asthma, digestive disturbances resulting from overactivity of those organs, spastic constipation, diabetes mellitus, infections and obesity. During illness those of the vagotonic type do not respond with a rapid stimulation of the defensive mechanisms of the body as do those belonging to the sympatheticotonic type. As a result, illnesses are apt to be more prolonged but recuperation rapid.

Neurologically, vagotonic patients should have stimulative treatment in the thoracic and upper lumbar regions and sedative treatment in the cervical, lower lumbar and sacral regions. This procedure stimulates the sympathetic system which neutralizes the overactivity of the parasympathetic nervous system. Likewise, they respond well to increased activity or exercise, massage and the Turkish bath type of elimination.

SYMPTOMATOLOGY OF AUTONOMIC IMBALANCE

That a disturbance in the innervation of any particular tissue or organ will cause a disturbance in the physiological function of that part is a fundamental fact. Symptoms, then, become the outward manifestation of disturbed function. In clinical practice it is important that the symptoms which may result from the two types of autonomic imbalance be firmly fixed in mind and so for more convenient reference, these symptoms are tabulated below under the headings of the various visceral parts.

Eye and Lacrimal Glands

Predominance of the sympathetic innervation to the eyes and lacrimal glands shows itself by a dilatation of the pupil, a widening of the palpebral fissure, an apparent protrusion of the eyeball and an abnormal dryness of the eyes.

Predominance of the parasympathetic innervation is indicated by a contracted pupil and an increased lacrimal secretion called epiphora.

Mucous Membranes of the Head

Predominance of sympathetic impulses leads to an underactivity of the glands and a constriction of the blood vessels of the mucous membranes. As a result, upon observation, the mucous membranes appear pale and subject to unusual dryness.

Predominance of the parasympathetic impulses leads to a dilatation of the blood vessels and an excessive secretion from the glands. Upon observation, the mucous membranes appear reddened and swollen and show signs of excessive mucous secretion. This form of disturbance is found in hay fever, sinusitis, rhinitis and pharyngitis. As a result of the functional changes already mentioned, the mucous membranes become excessively sensitive and irritable so that the slightest irritation usually evokes sneezing.

Salivary Glands

A decrease in the secretion of the watery components of the saliva is brought about by a predominance of sympathetic impulses reaching the salivary glands. This is a notable finding in any acute disease in which the patient complains of a dry mouth.

An increase in the watery components of the saliva is brought about by a predominance of the parasympathetic impulses reaching the salivary glands. This sometimes is seen as a reflex manifestation of certain gastric and pulmonary disorders not associated with an acute toxemia.

Thyroid Gland

Stimulation of the sympathetic nerves to the thyroid gland increases the production and secretion of thyroxin. The excessive secretion in turn acts as a stimulator of the entire sympathetic nervous system. This may be observed in hyperthyroidism or exophthalmic goiter.

A few branches of the vagus nerves have been traced to the thyroid gland but their stimulation seems to produce no changes in the function of the gland.

Bronchi and Lungs

Sympathetic predominance to the pulmonary organs leads to a vasoconstriction of the blood vessels, a decreased secretion from the glands of the mucous membrane and a relaxation of the small bronchial muscles.

Parasympathetic predominance to the pulmonary structures frequently is seen in practice. The results of such disturbances of the innervation is shown as a vasodilatation, increased mucous secretion and a constriction of the small bronchial muscles. As a result, difficulties in breathing and an over-sensitiveness of the bronchial mucosa may be experienced. The entire syndrome is observed best in cases of asthma. Parasympathetic predominance is further associated with bronchitis, tuberculosis and emphysema.

Heart

Predominance of the sympathetic innervation leads to an increase in the rate of contraction of the heart muscles with a corresponding increase in the force of contraction. This finding frequently is observed in any disorder associated with a general sympathetic stimulation such as in hyperthyroidism or acute toxemia.

Predominance of the parasympathetic innervation leads to a decrease in the rate and force of contraction of the heart muscles. There also is an interference in the passage of the impulses over the intrinsic nerves of the heart and thus the rhythm may become irregular. Experimentally, vagus stimulation has been made to produce heart block.

Stomach

Predominance of the sympathetic innervation to the stomach leads to a decrease in the tone of the gastric musculature, a constriction of the blood vessels, an inhibition of the gastric secretions and a diminution of the normal motility of the stomach. These functional changes may give rise to a wide variety of symptoms. Upon fluoroscopic or radioscopic examination, the stomach generally appears to be large and underactive so that it empties slowly and incompletely. A gastric analysis usually reveals a hypochlorhydria and thus the digestion of proteins is retarded with resulting decomposition of the food masses in the stomach giving rise to gas, nausea and even vomiting. Even slight predominance of the sympathetic innervation to the stomach impairs the appetite since appetite depends upon the normal contraction of the stomach walls and the secretion of gastric juices.

Predominance of parasympathetic innervation is associated with overactivity of the gastric functions. It results in an increased tonus of the gastric musculature with a hypermotility and a hypersecretion of hydrochloric acid. Fluoroscopic or radioscopic examination generally reveals a small, overactive stomach which empties prematurely and a gastric analysis reveals a hyperchlorhydria. Since the stomach empties prematurely, followed by the secretion of the gastric juices, the hydrochloric acid irritates the walls of the empty stomach and may give rise to hunger pains. Overactivity of the parasympathetics to the stomach is associated with hyperacidity of the stomach and gastric ulcer. Likewise, the functions may be similarly reflexly disturbed as a result of inflammations in other organs reached by the vagus nerves.

Small Intestine

As in the case of the stomach, sympathetic predominance in the innervation of the small intestine leads to a vasoconstriction with an inhibition of the motor and secretory functions. As a result, intestinal digestion and absorption is impaired and the passage of the food masses through the intestine is delayed.

Predominance of parasympathetic impulses reaching the small intestine leads to a hypersecretion and an overactive peristalsis.

Large Intestine

Sympathetic predominance to the colon and rectum results in a decreased tone of the colon muscles, a vasoconstriction, a decreased secretion from the glands of the mucosa and lessened peristalsis. This leads to the flabby, dilated colon seen in atonic constipation.

Parasympathetic predominance results in the production of an excessive tonus of the muscles of the colon along with an excessive secretion from the glands. As a result of the hypermotility, either diarrhea or spastic constipation may occur depending upon whether the circular or longitudinal muscles of the colon are involved. The increased secretion is best seen in cases of mucous colitis.

Liver and Gall Bladder

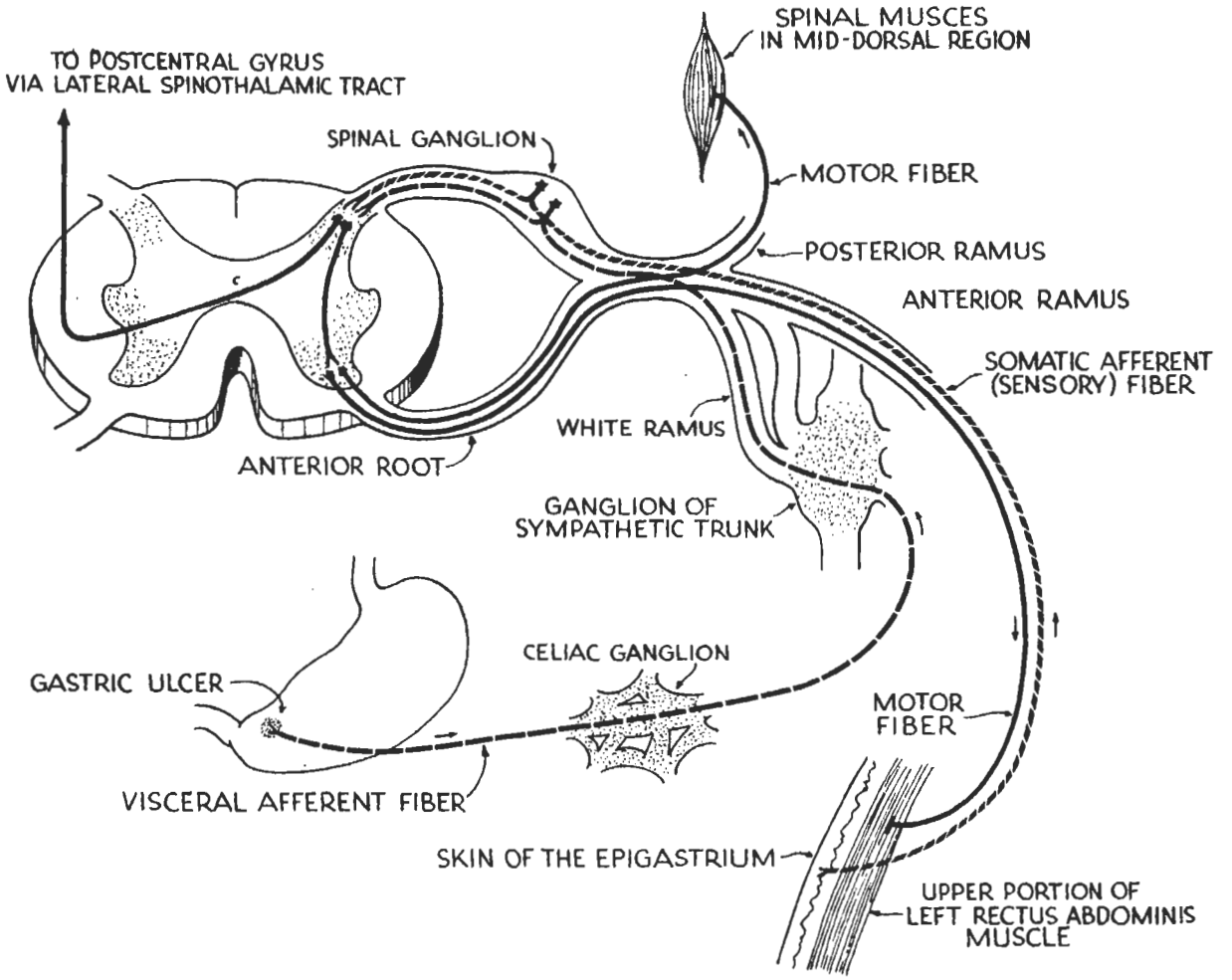
Since the sympathetic impulses inhibit the contraction of the gall bladder and consequently its complete emptying, a sympathetic predominance may predispose to the formation of gallstones and cause a deficient flow of bile into the intestinal tract during digestion. The sympathetics, it is said, also inhibit the secretion of cholesterol in the bile and consequently sympathetic predominance possibly may be a factor in the disturbance of the cholesterol balance in the body.

DISORDERS ASSOCIATED WITH AUTONOMIC IMBALANCE

From the foregoing, it may be learned that a large number of specific disorders may result from autonomic imbalance. The classification or grouping of these disorders, at least in part, lays the foundation for the type of treatment to be followed as far as that treatment will affect either branch of the autonomic nervous system. As a summary of the above discussions, these disorders are classified and repeated below.

The disorders most commonly associated with a sympathetic predominance are hyperthyroidism, dryness and paleness of the mucous membranes of the head, deficient salivary secretion, tachycardia, dilatation of the stomach, hypochlorhydria, poor digestion and atonic constipation.

Disorders associated with a parasympathetic predominance are epiphora, hay fever, sinusitis, rhinitis, pharyngitis, excessive salivary secretion, bradycardia, asthma, tuberculosis, hyperchlorhydria, peptic ulcer, diarrhea, spastic constipation, mucous colitis and anaphylaxsis.



The gastric ulcer, acting as a severe irritant, initiates the flow of an abnormal stream of impulses which pass via visceral afferent fibers to reach the posterior horns of the middle thoracic segments of the spinal cord. Mackenzie suggests that as a result of the entrance of this abnormal stream of impulses, an area of hyperemia occurs in the posterior horns (the "irritable focus" of Mackenzie) which lowers synaptic resistance and thus at least two viscero-somatic responses may be observed: First, the afferent impulses pass via association fibers to the anterior cell columns where they initiate motor impulses which pass outward over corresponding spinal nerves thus resulting in contraction of the muscles in the middle dorsal region and in the upper portion of the left rectus abdominis muscle. Second, other afferent impulses pass to sensory pathways which ascend to the postcentral gyrus to be interpreted as pain; however, since these ascending fibers ordinarily carry pain impulses from the skin of the epigastric region, the brain continues to interpret these impulses as coming from that region instead of from the stomach. Because of this phenomena, the pain of the gastric ulcer is referred to the skin of the epigastrium.

Figure 9

THE PROBABLE MECHANISM OF REFLEX SYMPTOMS

Chapter Four

REFLEX SYMPTOMATOLOGY

It already has been stated that under ordinary circumstances the afferent impulses from the visceral organs serve chiefly to initiate the normal efferent outflow of visceral impulses. In this is a mechanism by which the organs and the body as a whole react and adapt themselves to alterations of external environment and internal changes. In visceral irritations or inflammations the afferent impulses from the affected organ are greatly increased so that they overcome the resistance ordinarily offered to normal impulses at certain synapses with the result that many new and unusual reflex connections are established bringing about the appearance of abnormal activities which may be termed symptoms. In general, the visceral organs are insensitive to mechanical, chemical, thermal and electrical stimulation in the ordinary sense, i. e., the application of these stimuli to the visceral organs, with certain exceptions, does not give rise to the sensations that would occur if the same stimuli were applied to the superficial areas of the body. Rather, when pathology exists in a visceral organ, the resulting afferent impulses may give rise to sensations but these either are not definitely localized or they are referred to a somatic or visceral area removed from the point of pathology.

When an organ is involved in severe inflammation or is otherwise markedly irritated, two groups of reflex symptoms are initiated.

1. Parasympathetic reflexes are initiated in which impulses resulting from an irritation in the organ are carried to the center over the afferent fibers associated with the parasympathetic nerves. These initiate efferent impulses which are transmitted outward over the various branches of the same or other nerves of the parasympathetic system resulting in symptoms of predominating parasympathetic activity in other organs.

2. Viscero-somatic responses also are originated in which other impulses resulting from the irritation in the organ are caried over afferent nerves associated with the sympathetic pathway to the spinal cord where they may relay to ascending fibers or to somatic efferent nerves. These manifest themselves as sensory interpretations, motor changes and later, in chronic cases, as trophic changes in the skin, subcutaneous tissues and the muscles supplied by the spinal nerves.

PARASYMPATHETIC REFLEXES

Parasympathetic reflexes are met in every disease of consequence affecting important viscera. These reflexes generally take place from one viscus back to the same or other visceral organs. In this way, even though the pathological lesions may be confined to one organ, there may be a disturbance in the function of other organs innervated by the parasympathetic nervous system. It is by this mechanism that a gastric ulcer may cause such symptoms as increased salivary secretion, esophageal spasms, hypermotility of the stomach and intestines, and hypersecretion of the gastric and intestinal glands.

Specifically, the reflex pathways in this case would be as follows:

The impulses are transmitted inward over the visceral afferent fibers of the vagus nerves and due to the severe irritation of the ulcer, the impulses are so exaggerated that they overcome the resistance offered by the synapses in the nuclei of these afferent fibers. As a result, the impulses are relayed to association fibers which in turn synapse with the parasympathetic efferent fibers arising from various nuclei in the brain stem. Those in the superior salivary nucleus send fibers by way of the facial nerve to the submaxillary and sublingual salivary glands. Those in the inferior salivary nucleus send fibers by way of the glossopharyngeal nerve to the parotid gland. Those in the dorsal motor nucleus of the vagus nerve give rise to parasympathetic fibers which reach the esophagus, stomach and intestines. Theoretically at least, it might be possible for all the cranial parasympathetic fibers including all the branches of the vagus to be reflexly stimulated in this manner bringing about symptoms of parasympathetic overactivity in all the organs reached by these fibers. This rarely may be seen in clinical practice although frequently reflex manifestations are widespread.

Asthmatic symptoms (these generally are associated with parasympathetic predominance in the innervation to the bronchi) may occur as a result of irritations either within the bronchi themselves or from other organs such as the stomach, intestines, nasal cavity, eyes, sinuses or teeth. In the case of irritations in the nasal cavity, sinuses, eyes or teeth, the afferent impulses are transmitted inward to the center over the sensory fibers of the trigeminal nerve and due to the exaggerated nature of the impulses, set up synaptic relationships with parasympathetic fibers passing to the bronchi. In other cases, disturbances in the stomach may be found as a result of inflammation or other irritations in the appendix, gall bladder or intestinal tract. Still another example would be the slowing of the heart seen in certain abdominal or pulmonary diseases not accompanied by acute toxemias. It is important to note that the outstanding symptoms of the syndrome may be reflex in nature produced by irritation in some other organs and often the primary irritation may produce few if any symptoms which are noticeable to the patient. Chronic inflammation of the appendix or gall bladder is perhaps the chief offender in this manner.

VISCERO-SOMATIC RESPONSES

Viscero-somatic responses arise as a result of irritations within visceral organs in which the impulses are carried by visceral afferent fibers to reach the spinal cord (Fig. 9).

There, due to the exaggerated intensity of the impulses, they overcome the resistance offered by the synapses and thus stimulate somatic fibers which pass either to the brain where they are interpreted as pain referred to superficial areas, or to motor fibers which reach skeletal muscles. It is by this mechanism that the upper portion of the rectus abdominis muscle may be contracted in severe stomach irritations, that the pain of angina pectoris is referred to the skin and subcutaneous tissues of the precordium and the inner side of the left arm, or that areas of muscular contraction and tenderness occur in specific areas along the spinal column in visceral diseases. The mechanism by which these responses are manifest may be described best by outlining the pathways over which the impulses travel in specific visceral diseases.

The Mechanism of Reflex Muscular Contraction

In the case of a stomach irritation, the impulses are transmitted by visceral afferent fibers to the fifth to ninth thoracic spinal segments and there, either directly or by way of association fibers, synapse with somatic motor fibers whose cell bodies are located in the anterior cell column. These fibers then pass to the upper portion of the left rectus abdominis muscle and to the spinal muscles in the region of the 5th, 6th and 7th thoracic vertebrae causing contraction of these muscles. Thus, if the gastric disturbance resulted from the ingestion of irritating substances, the contraction of the spinal muscles may cause spinal lesions in this region due to the imbalanced tension of the muscles attached to the verterbrae.

Trophic Changes

In chronic diseases, due to the long continued reflex contraction of the various muscles, the normal circulation and nutrition is prevented and thus trophic changes occur particularly in the subcutaneous tissues and the skeletal muscles in these areas. This is seen notably in the supraclavicular and infraclavicular spaces in cases of pulmonary tuberculosis.

The Mechanism of Referred Pain

In the case of angina pectoris, the impulses are transmitted by visceral afferent fibers to the upper three or four thoracic segments of the spinal cord and there, in addition to bringing about certain areas of muscular contraction as explained above, overcome the synaptic resistance and travel through somatic sensory fibers which ascend to the thalamus and relay to fibers which reach the cerebral cortex. These ascending fibers ordinarily carry pain impulses from the skin and subcutaneous tissues in the regions supplied by the related thoracic nerves. When these impulses reach the cerebral cortex via these somatic fibers, they continue to be interpreted as arising from the skin and subcutaneous tissues rather than from the heart and thus the pain of angina pectoris is referred to the inner side of the left arm and the anterior wall of the left side of the chest. Figure 9 illustrates the pathway of the impulses giving rise to referred pain in the case of a gastric ulcer. The general principles of the mechanism is identical regardless of the organ involved.

Table of Viscero-Somatic Responses

The application of the few facts given here concerning the nature of visceral reflexes and the manner in which they express themselves are of utmost importance in clinical practice. They offer an explanation for the greater part of the symptoms commonly met in visceral disease. Furthermore, they offer valuable aid in diagnosis because each organ, when inflamed or otherwise irritated, expresses its reflexes regularly in the same skin, subcutaneous or muscular structures. For convenience in reference, the areas of reflex muscular contraction and the areas of referred pain for each of the major visceral organs have been tabulated on the opposite page.

TABLE OF VISCERO-SOMATIC RESPONSES OCCURRING IN VISCERAL DISEASE

ORGAN	*AREAS OF REFLEX MUSCULAR CONTRACTION*	*AREAS OF REFERRED PAIN*
Bronchi and Lungs	Muscles of the shoulder girdle and diaphragm	Skin, subcutaneous tissue and muscles of the shoulder above the level of the 2nd rib anteriorly and the spine of the scapula posteriorly
Heart	First to fourth intercostal muscles	Upper half of the left side of the chest and extending outward and down the inner surface of the left arm and hand
Stomach	Upper portion of the left rectus abdominis muscles	Epigastrium
Small Intestine	5th to 11th intercostals, rectus abdominis, transversalis and the internal and external abdominal oblique	Area centering about the umbilicus
Colon	Psoas major and minor and the lower portions of the transversalis, rectus abdominis and the internal and external abdominal oblique	Lower right and left quadrants of the abdomen
Liver and Gall Bladder	Upper portion of the right rectus abdominis	Over the upper part of the right rectus abdominis, to the right of the 5th to 9th thoracic vertebrae, and the right shoulder region (via phrenic nerve)
Appendix	Muscles of the lower right quadrant	Centering in the lower right quadrant
Pancreas	Upper portion of the left rectus abdominis	Over the upper part of the left rectus abdominis
Kidneys	Spinal muscles in the region of the 9th to 12th thoracic vertebrae and the lumbar muscles	Below the level of the umbilicus, the entire lumbar region, and the upper half of both the inner and outer portions of the thigh
Ureter	Spinal muscles from the 9th thoracic to 4th lumbar, transversalis and cremasteric muscles	Groin to the scrotum or vulva and the inner side of the thigh
Urinary Bladder	Lower part of the rectus abdominis	Above the pubis, over the sacrum and the perineum
Prostate	Indefinite	Above the pubis, both sides of the 10th and 11th thoracic vertebrae, the buttocks, inner surface of the thigh, heel and sole of the foot
Uterus	Indefinite	Over the pubis, groin, lumbar and sacral regions and the mammary regions

Chapter Five

INHIBITION AND STIMULATION -- AN APPROACH TO THERAPY

It already has been stated in previous chapters that most organs have a dual nerve supply. Most organs are reached by both sympathetic and parasympathetic fibers and when this is true, the impulses received by the organ from these two systems are antagonistic in their influence upon the functions of the organ. If the impulses from one system stimulate, then the impulses from the other system inhibit. Normal function results from a balance in the activity of the two systems unless the organ is disturbed by abnormal body chemistry. In some organs, the sympathetics activate while the parasympathetics depress the functions; in other organs the reverse is true so it cannot be said that one division has a similar influence upon all organs which it innervates.

It follows naturally that if there be a disturbance in the transmission of the normal nerve impulses by one set of the nerves to an organ, the normal balance in the innervation is lost and consequently the organ will manifest changes in function. If the activating set of nerves is stimulated, the organ will be overactive. If the activating nerves are inhibited, the organ will be underactive. If the inhibiting nerves are stimulated, the organ will be underactive. If the inhibiting nerves are depressed, the organ will be overactive, because the activating nerves then will be only weakly opposed and will have the greater share of control.

It is of utmost importance to know the influence of each of the two sets of nerves upon a given organ and to understand the result of either stimulation or inhibition when applied to these nerves. It is evident there would be an aggravation of symptoms if we were to apply stimulation to the activating nerves to an already overactive organ. Likewise, unfavorable results would occur in this same case if inhibition were applied to the nerves which normally inhibit the functions of the organ because this would further reduce the influence of the nerves which normally oppose the activators. In the case of an overactive organ, the logical procedure would be inhibition of the activating nerves and stimulation of the inhibiting nerves. In the case of an underactive organ, treatment should be given which will stimulate the activating nerves and depress the inhibiting nerves.

In Part Two of this monograph, the clinical application of the innervation of the various organs has been considered under two headings, namely, (1) the disorders associated with a *predominance of the sympathetic supply,* and (2) the disorders associated with a *predominance of the parasympathetic supply.* Function within the organ involved, of course, will be altered in favor of the predominating system. Thus, predominating sympathetic activity in an organ normally activated by the sympathetics will be overactive. Predominating sympathetic activity in an organ normally inhibited by the sympathetics will be underactive. The same rules may be applied to the parasympathetic system.

Predominating sympathetic activity may be due to (1) factors which stimulate the sympathetic fibers, (2) factors which inhibit the parasympathetic fibers, or (3) chemical imbalance. *Predominating parasympathetic activity* may be due to (1) factors which stimulate the parasympathetic fibers, (2) factors which inhibit the sympathetic nerves, or (3) chemical imbalance.

Factors which may stimulate sympathetic fibers include irritative spinal lesions; action of toxins associated with acute infections; certain endocrine disturbances particularly overactivity of the thyroid and adrenals; action of certain drugs; and certain psychic states, particularly fear, anger, pain, worry, excitement and hate.

Factors which may inhibit sympathetic fibers include inhibitive spinal lesions and depletion of the endocrine glands which cooperate with the sympathetic nervous system (anterior pituitary, thyroid, adrenals, and gonads) which may occur as a result of prolonged illness.

Factors which may stimulate parasympathetic nerves include irritative spinal lesions and reflexes from irritations or inflammations in another organ reached by the parasympathetic system.

Factors which may inhibit the parasympathetic nerves include inhibitive spinal lesions and the action of certain drugs.

Besides the above factors, the electro-chemical states of the cells of the tissues must be considered. Cellular response to nerve impulses depends upon the chemical states of those cells. In cases of disturbances in the chemistry of the cells, they either may not react at all to certain nerve impulses or they may react in an unexpected or contradictory manner. Thus, even though normal nerve impulses reach an organ, the functions of the organ still may be disturbed due to chemical imbalances. Particularly noteworthy is the role of calcium. Cellular response to sympathetic impulses seems to depend upon adequate supplies of calcium. Without adequate calcium, the cells become relatively more responsive to parasympathetic impulses and consequently may show functional abnormalities characteristic of predominating parasympathetic activity.

In this monograph, spinal lesions have been considered as capable of producing either stimulation or inhibition—depending upon the length of time the lesion has existed. An acute or recently acquired lesion in which the spinal cord center is engorged with blood in active congestion, generally may be considered a stimulative lesion. During this stage, the nerve center is in an excitable condition and is more responsive to reflex stimulation. The tissues surrounding the lesion are apt to be tender and tense, appear

slightly reddened, and feel warm. If further treatment is given after the lesion is corrected, it should be inhibitive.

A spinal lesion which has existed for considerable time is generally associated with an underactivity of the related nerve center, that is, the center is less excitable, is less responsive to reflex stimulation, and the number of impulses sent out from the center is reduced. This is due probably to a passive congestion in the center and fatigue from over-activity during the acute stage. In addition to correction of the spinal lesion in such cases, measures which induce stimulation may be found beneficial.

THERAPEUTIC APPLICATIONS

In all cases of autonomic imbalance, the correction of the etiological spinal lesions is, of course, fundamental regardless of whether that lesion be irritative or inhibitive. Likewise, it is important to correct or remove other primary causative factors which are acting to bring about abnormal activity of one or the other of the divisions of the autonomic nervous system. In addition, however, much may be accomplished towards re-establishing a normal balance in the innervation to a disordered organ by the application of stimulative or inhibitive measures to the respective nerves as the case may require.

Below are described a number of methods of stimulation and inhibition which may be used to supplement or reinforce manipulative therapy. When these measures are used as suggested in the discussions in Part Two, they may be found valuable in aiding in the re-establishing of normal physiological activity in the disordered organ.

CONCUSSION

Concussion may be applied with the use of either the plexor and pleximeter or the hands. If the hands are used, the palmar surfaces of the fingers are placed over the spinous processes to be concussed and these are struck with the clenched fist of the other hand.

For stimulation, the strokes should be firm and vigorous and should be delivered at the rate of one stroke about every second. 20 to 25 strokes should be delivered followed by a similar period of rest after which another 20 to 25 strokes are delivered. This is repeated until 3 to 5 periods of concussion have been given.

For inhibition, concussion is given rapidly and without rest periods for from 3 to 5 minutes.

PRESSURE

Pressure may be applied with the use of a single or double pressor or the tips of the thumbs may be used. In either case, the pressure is applied in the paravertebral space over the point of exit of the nerves to be influenced.

For stimulation, pressure should be applied for a period not to exceed 30 seconds. Contact should be made suddenly and broken suddenly.

For inhibition, hard pressure should be maintained for 3 to 5 minutes.

FREEZING

Used for *inhibition* only. Ice sprinkled with salt may be wrapped in a thin cloth and held to the skin over the spinal area to induce inhibition of the nerves in the given area.

HEAT

Heat may be used to enhance the conductivity of a nerve or the activity of a nerve center and may be used with other measures to induce stimulation. Heat may be applied through the use of a diathermy, short wave, infrared or a heating pad.

VIOLET RAY SPARKING

The high frequency current using the double spinal electrode applied over the exits of spinal nerves enhances their function.

SINUSOIDAL CURRENT

There are two methods of application of sinusoidal current. (1) Using two 2x3 inch moist pads and placing them opposite each other, one on either side of the spine in the region of the nerves involved. (2) Using the small either single or double disc electrode over the exits of the nerves involved with a large indifferent electrode placed over the sacrum.

For stimulation, an interrupted current is used as strong as the patient can tolerate for a period not to exceed two minutes.

For inhibition, a strong, uninterrupted current is used for 5 to 10 minutes.

For sedation, a mild, surging current is used for 20 to 25 minutes. The ultimate results of this application are the same as for the inhibiting treatment but is more pleasant to the patient.

STIMULATION OF THE VAGUS

It is said that any of the stimulative measures applied to the seventh cervical will stimulate vagus activity. Concussion of the upper two cervical vertebrae also tends to stimulate the vagus. Stimulative sinusoidal applications with one pad placed in the upper cervical region and the other pad over the epigastrium has been shown on fluoroscopy to markedly increase gastric motility. Passing the fingers vigorously forward and backward over the vagus nerve in the neck (the vagus is situated under the sternocleidomastoid muscle) also has been shown to stimulate the vagus.

PART TWO

In this second part is presented an outline of the innervation of the more important viscera with a study of the clinical application. The study is approached from the standpoint of autonomic imbalance and is discussed under two headings, namely, the disorders associated with sympathetic predominance and the disorders associated with parasympathetic predominance. The common causative factors, the possible effects and the logical therapeutic approach are considered under each of the two headings. No effort has been made to outline all the various forms of therapy which would be beneficial in these cases. Rather, the suggestions listed in the outline under the subheading of "treatment" are intended to serve only as a general guide in the application of those therapeutic agents which may be useful in establishing a more normal balance in the functions of the two divisions of the autonomic nervous system. For the most part, this resolves itself into a process of stimulating the underactive division and inhibiting the overactive. For methods of stimulating and inhibiting nerve centers, the reader is referred to Chapter 5 in Part One.

A study of the visceral and somatic responses or reflexes which may arise as a result of visceral disease also is presented. A thorough study of these reflexes will give a better understanding of many of the symptoms met in visceral disease. Furthermore, a knowledge of the somatic areas in which the various organs express their reflexes when diseased, will give an immeasurable aid in diagnosis. It is hoped that the material presented in this Part will prove useful enough to serve as a reference guide in everyday practice.

1 ~ THE MUCOUS MEMBRANES OF THE HEAD

Innervation

SYMPATHETIC: Sympathetic visceral branches from the first four thoracic nerves

Functions: Produce vasoconstriction and thereby decrease the secretion from the glands of the mucous membranes

PARASYMPATHETIC: Seventh cranial nerve

Functions: Dilate the blood vessels and activate the secretory glands

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of the sympathetic supply* caused by irritative spinal lesions in the region of the 1st to 4th thoracic nerves or any factors which may stimulate the sympathetic system in general.
2. *Inhibition of the parasympathetic supply.*

POSSIBLE EFFECTS

The nasal mucosa becomes excessively dry and pale due to the decreased activity of the secretory glands and the constriction of the blood vessels of the mucosa.

TREATMENT

Correct any existing irritative spinal lesions in the thoracic region and apply inhibition to the 1st to 4th thoracic nerves.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. *Parasympathetic stimulation* due reflexly to irritations in other organs reached by parasympathetic nerves as in irritations or inflammations involving the teeth, bronchi, stomach, intestines or gall bladder.
2. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 1st to 4th thoracic nerves or due to depletion of the endocrine glands synergistically related to the sympathetic nervous system, especially the thyroid and adrenals.

POSSIBLE EFFECTS

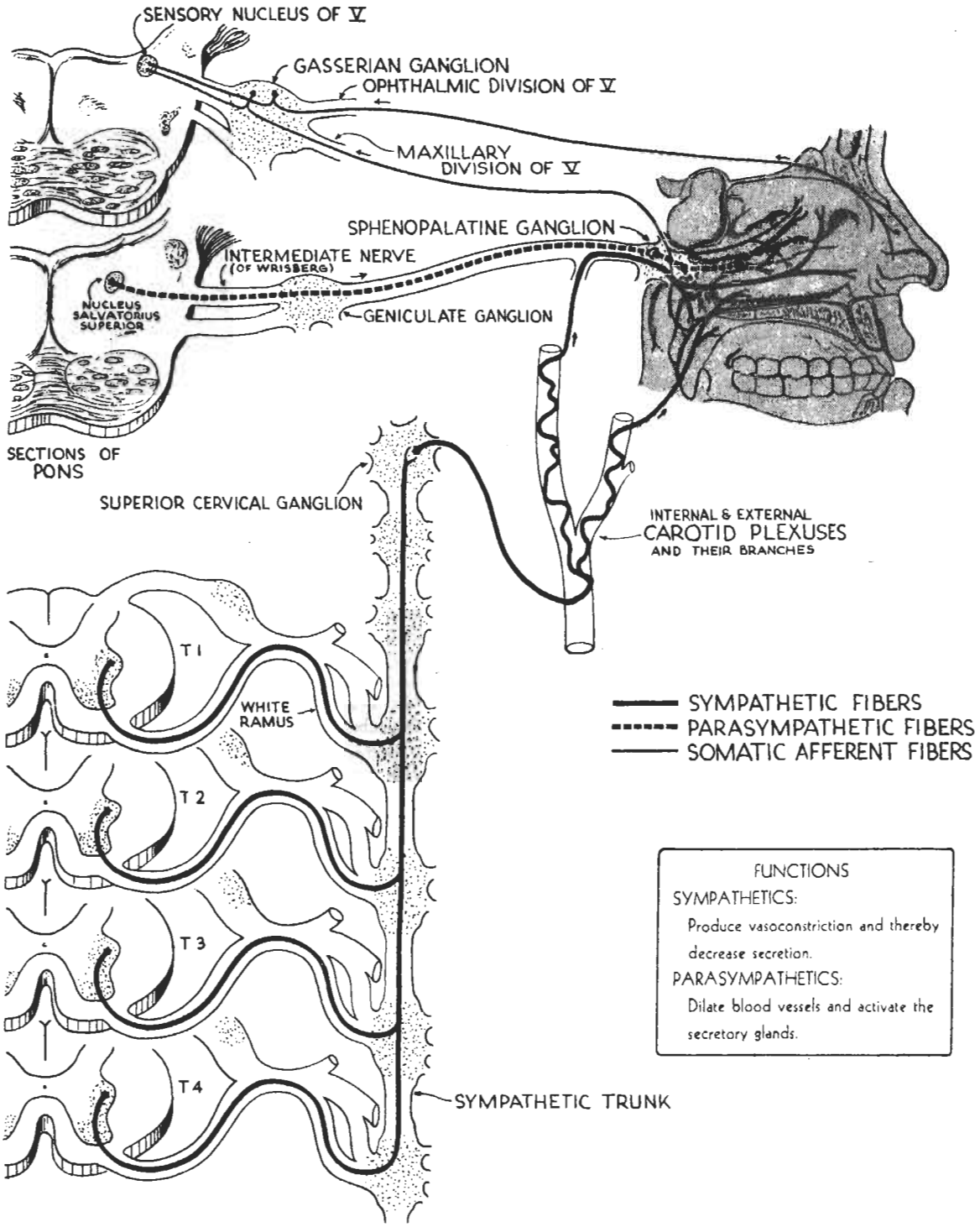
The nasal mucosa becomes congested and swollen and the glands become overactive producing an excessive secretion of mucus.

TREATMENT

1. Correct contributing and reflex etiological factors.
2. Correct inhibitive spinal lesions in the thoracic region and apply stimulation to the 1st to 4th thoracic nerves.

REFLEX RESPONSES

When the mucosa of the nasal cavity or sinuses becomes irritated from inflammation or other causes, there may occur a reflex stimulation of other cranial parasympathetic fibers and thus occasionally may cause asthmatic symptoms, hyperchlorhydria or spastic constipation.



THE INNERVATION OF THE MUCOUS MEMBRANES OF THE NASAL CAVITY AND SINUSES

2 ~ THE LACRIMAL AND SALIVARY GLANDS

Innervation

SYMPATHETIC: Sympathetic visceral branches from the first four thoracic nerves

Functions: In the lacrimal glands, the sympathetics exert a vasomotor control and probably inhibit the secretion. In the salivary glands, the sympathetics produce a vasoconstriction and thereby decrease the secretion of the watery elements of the saliva and consequently increase the relative quantity of the organic substances

PARASYMPATHETIC: The seventh cranial nerve to the lacrimal, submaxillary and sublingual glands; the ninth cranial nerve to the parotid gland

Functions: In the lacrimal glands, the parasympathetics increase the secretion. In the salivary glands, the parasympathetics probably produce a vasodilatation and thereby increase the watery elements of the saliva

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of the sympathetic supply* caused by irritative spinal lesions in the region of the 1st to 4th thoracic nerves; action of toxins associated with acute infections; psychic states as fear, anger, pain, worry, excitement, etc.; or certain endocrine disturbances causing general sympathetic stimulation.
2. *Inhibition of the parasympathetic supply.*

POSSIBLE EFFECTS

Decreased secretion from the glands leading to dryness of the eye or of the mouth

TREATMENT

Correct any existing irritative spinal lesions in the thoracic region and apply inhibition to the 1st to 4th thoracic nerves.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

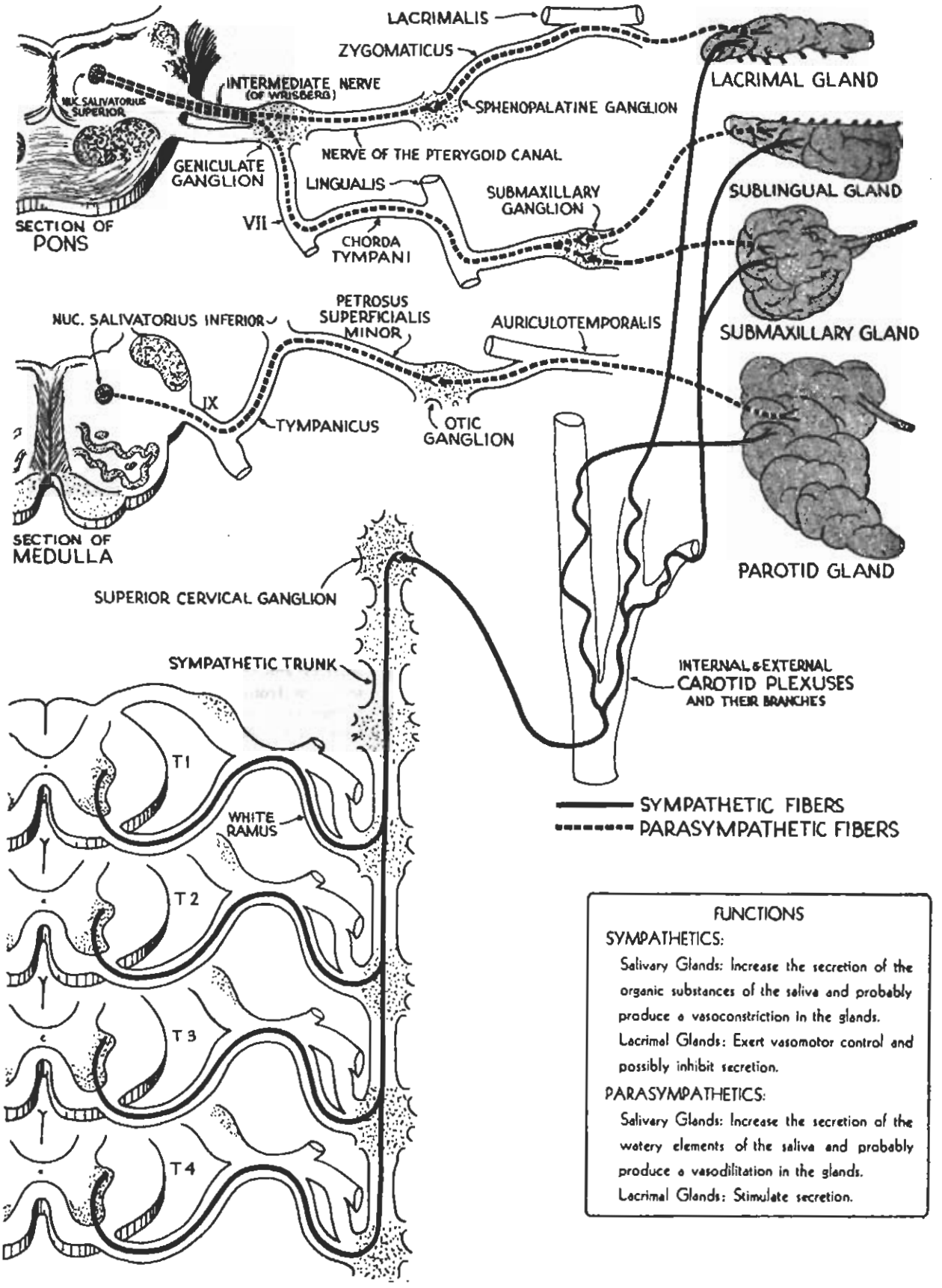
1. *Parasympathetic stimulation* due reflexly to irritations in other organs reached by parasympathetic nerves as in irritations or inflammations involving the eye, mucosa of the nasal cavity and sinuses, bronchi, lungs, stomach, intestines or gall bladder.
2. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 1st to 4th thoracic nerves or due to the depletion of the endocrine glands synergistically related to the sympathetic nervous system, especially the thyroid and adrenals.

POSSIBLE EFFECTS

Excessive secretion from the glands.

TREATMENT

1. Correct contributing and reflex etiological factors.
2. Correct inhibitive spinal lesions in the thoracic region and apply stimulation to the 1st to 4th thoracic nerves.



FUNCTIONS

SYMPATHETICS:

Salivary Glands: Increase the secretion of the organic substances of the saliva and probably produce a vasoconstriction in the glands.

Lacrimal Glands: Exert vasomotor control and possibly inhibit secretion.

PARASYMPATHETICS:

Salivary Glands: Increase the secretion of the watery elements of the saliva and probably produce a vasodilitation in the glands.

Lacrimal Glands: Stimulate secretion.

THE INNERVATION OF THE SALIVARY AND LACRIMAL GLANDS

3 ~ THE TRACHEA, BRONCHI AND LUNGS

Innervation

SYMPATHETIC: Sympathetic visceral branches from the first four or five thoracic nerves

Functions: Dilate the bronchi and constrict the bronchial blood vessels and thereby possibly decrease the secretion of mucus

PARASYMPATHETIC: Vagus nerves

Functions: Constrict the bronchi and possibly increase the secretion of mucus

Clinical Application

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. ***Vagal stimulation*** due reflexly to upper cervical lesions, to irritations within the bronchi, or to inflammation in other organs reached by parasympathetic nerves as in sinusitis, rhinitis, tonsillitis, gastroenteritis or colitis.
2. ***Underactivity of the sympathetic supply*** due to inhibitive lesions in the region of the 1st to 5th thoracic nerves.
3. ***Changes in the cellular chemistry*** of the pulmonary tissues with a relative increase in potassium over calcium and a shift of the acid-base balance towards the alkaline side causing greater responsiveness of these tissues to parasympathetic impulses.

POSSIBLE EFFECTS

Constriction of the bronchial musculature, dilatation of the pulmonary blood vessels and an increase in the secretion of mucus giving rise to symptoms as seen in either bronchitis or asthma.

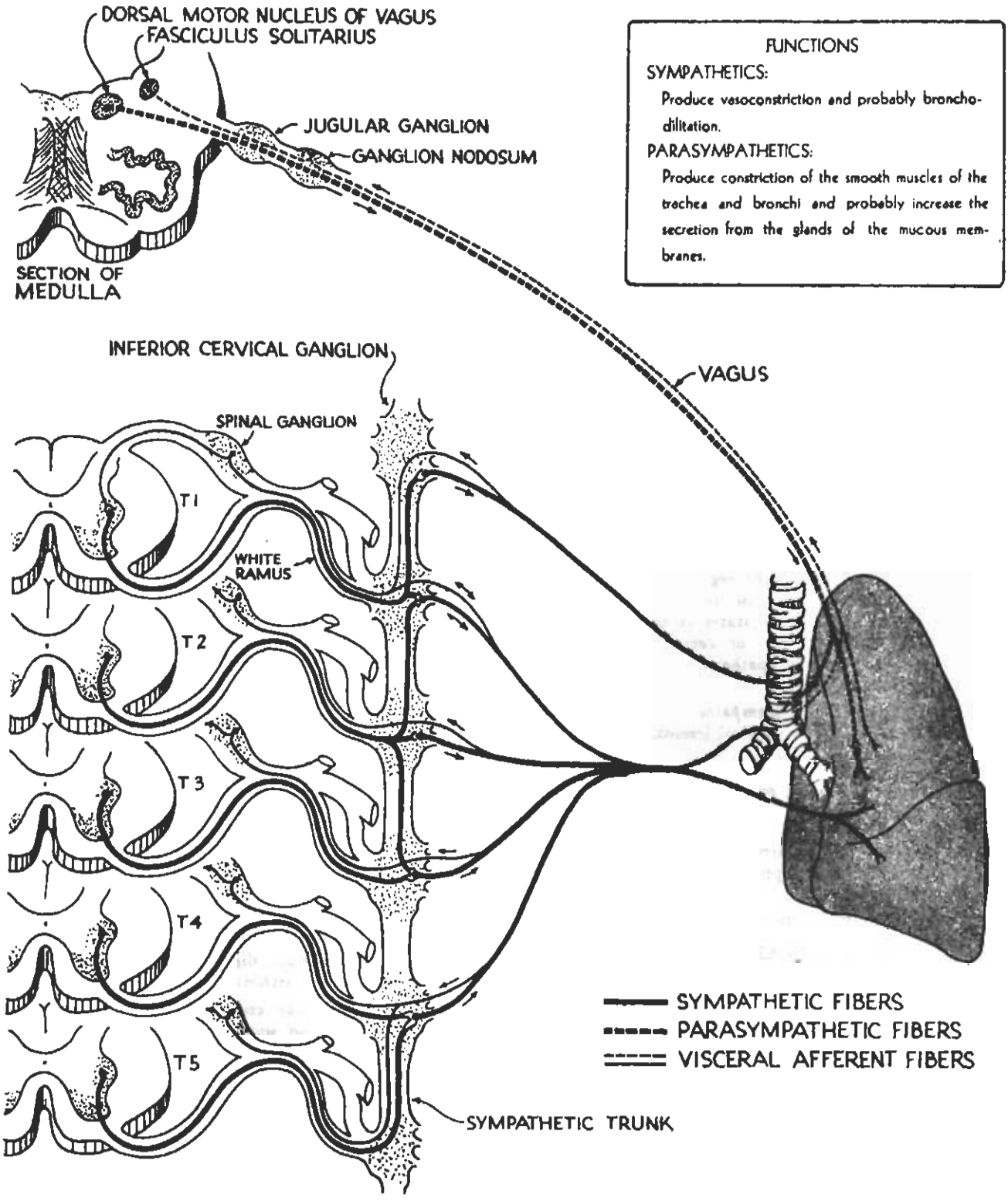
TREATMENT

1. Correct contributing and reflex etiological factors.
2. Inhibit vagal activity.
3. Correct inhibitive spinal lesions in the thoracic region and stimulate especially the first four thoracic nerves.
4. Consider possibility of tissue chemical imbalance and the advisability of increasing calcium intake.

VISCERAL AND SOMATIC RESPONSES

When the trachea or bronchi are involved in inflammation or are otherwise irritated, three responses or reflexes may be observed in visceral and somatic structures outside the trachea and bronchi:

1. Other organs reached by parasympathetic fibers may be stimulated reflexly and manifest changes in function characteristic of predominating parasympathetic activity and thus there may occur an increase in the secretion from the glands of the nasal mucosa, disturbances in the function of the vocal cords causing hoarseness, laryngeal irritation causing cough, slowing of the heart rate, and if the bronchial lesions are nontoxic, an increased secretion from the gastric and intestinal glands and a hypermotility of the stomach and intestines.
2. Reflex muscular contraction involving the diaphragm, the muscles in the region of the 1st to 4th thoracic vertebrae, and the muscles of the shoulder girdle (sternocleidomastoid, scaleni, pectoralis major and minor, trapezius, subclavius, levator anguli scapulae and the rhomboidei). The spastic contraction of these muscles causes a limitation of respiratory movement on the affected side. When the pulmonary lesion becomes chronic, atrophic changes may be observed in these muscles as a result of the long continued spastic contraction.
3. Pain may be referred to the muscles of the shoulder girdle and to the skin of the neck and the shoulder above the level of the 2nd rib in front and the spine of the scapulae in back.



THE INNERVATION OF THE TRACHEA, BRONCHI AND LUNGS

4 ~ THE HEART

Innervation

SYMPATHETIC: Sympathetic visceral branches from the first four or five thoracic nerves

Functions: Dilate the coronary arteries, accelerate the heart rate and augment the force of contraction

PARASYMPATHETIC: Vagus nerves

Functions: Constrict the coronary arteries and depress all activities of the heart—impulse formation, conductivity and contractility—with the result that the heart is slowed, the impulse conductivity diminished and the force of contraction lessened

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of the sympathetic supply* caused by irritative spinal lesions in the region of the 1st to 5th thoracic nerves; action of toxins associated with acute infections; psychic states as fear, anger, pain, worry, excitement, etc.; or certain endocrine disturbances causing sympathetic stimulation (especial hyperthyroidism).
2. *Inhibition of the parasympathetic (Vagus) supply* due possibly to upper cervical lesions.

POSSIBLE EFFECTS

Acceleration of the heart rate.

TREATMENT

1. Correct any existing irritative spinal lesions in the thoracic region and apply inhibition to the 1st to 4th thoracic nerves.
2. Stimulate parasympathetic (Vagal) activity.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. *Vagal stimulation* due reflexly to upper cervical lesions or to irritations in other organs reached by parasympathetic fibers as in irritations or inflammations involving the nasal mucosa, lungs, stomach, intestines, liver, gall bladder or appendix.
2. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 1st to 5th thoracic nerves.

POSSIBLE EFFECTS

Slowing of heart rate (bradycardia) and possibly a tendency to heart block and coronary spasm.

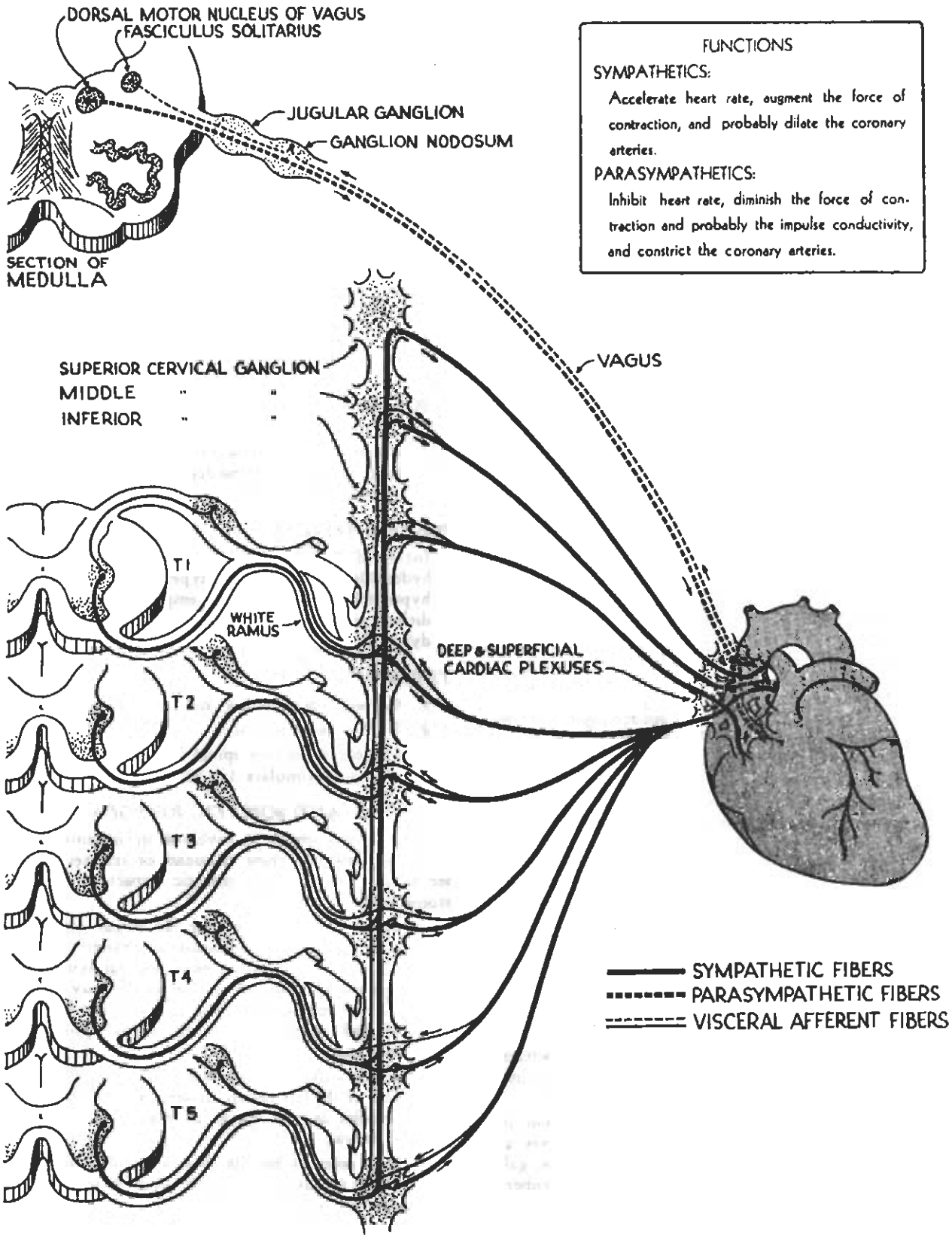
TREATMENT

1. Correct contributing and reflex etiological factors.
2. Inhibit vagal activity.
3. Correct inhibitive spinal lesions in the thoracic region and stimulate especially the first four thoracic nerves.

VISCERAL AND SOMATIC RESPONSES

When the heart is involved in a pathological process such as coronary occlusion, three responses or reflexes may be observed in visceral and somatic structures outside the heart:

1. Other organs reached by the vagus may be stimulated reflexly and manifest changes in function characteristic of predominating parasympathetic activity and thus there may occur such symptoms as nausea, vomiting, digestive disturbances and those seen in cardiac asthma and bronchitis.
2. Reflex muscular contraction involving the upper intercostals and sometimes the muscles of the arm and neck frequently may be seen in cases of severe cardiac lesions as in the case of coronary spasm or occlusion.
3. Pain may be referred to the skin and subcutaneous tissue in upper half of the left chest and down the inner surface of the arm and hand to the tips of the ring and little fingers.



THE INNERVATION OF THE HEART

5 ~ THE STOMACH

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 5th to 9th thoracic nerves

Functions: Inhibit gastric motility and the secretion of hydrochloric acid and water and may stimulate the secretion of gastric enzymes

PARASYMPATHETIC: Vagus nerves

Functions: Stimulate gastric motility and the secretion of hydrochloric acid and water

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of sympathetic supply* caused by irritative spinal lesions in the region of the 5th to 9th thoracic nerves; action of toxins associated with acute infections; psychic states as fear, anger, pain, worry, excitement, etc.; or certain endocrine disturbances causing sympathetic stimulation.
2. *Inhibition of the parasympathetic (Vagus) supply* due possibly to upper cervical lesions.

POSSIBLE EFFECTS

Relaxation of gastric musculature, reduced gastric motility and decreased secretion of hydrochloric acid causing dilatation of the stomach (gastrectasis), delayed emptying of the stomach, hypochlorhydria and deficient gastric digestion with feeling of fullness or distress after eating, poor appetite, belching and abdominal distention.

TREATMENT

1. Correct any existing irritative spinal lesions in the thoracic region and apply inhibition to the 5th to 9th thoracic nerves.
2. Stimulate parasympathetic (Vagal) activity.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. *Vagal stimulation* due reflexly to irritations within the stomach as in gastritis, ulcer or irritating substances in the stomach.
2. *Vagal stimulation* due reflexly to inflammation in other organs reached by parasympathetic nerves as in chronic appendicitis, inflammation of the gall bladder, duodenal ulcer, enteritis, pulmonary tuberculosis, sinusitis, eye strain, etc.
3. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 5th to 9th thoracic nerves.

POSSIBLE EFFECTS

Increased gastric motility and excessive secretion of hydrochloric acid causing hyperchlorhydria and a small, hyperactive stomach which empties quickly. These conditions predispose to gastritis, gastric ulcer and nervous dyspepsia.

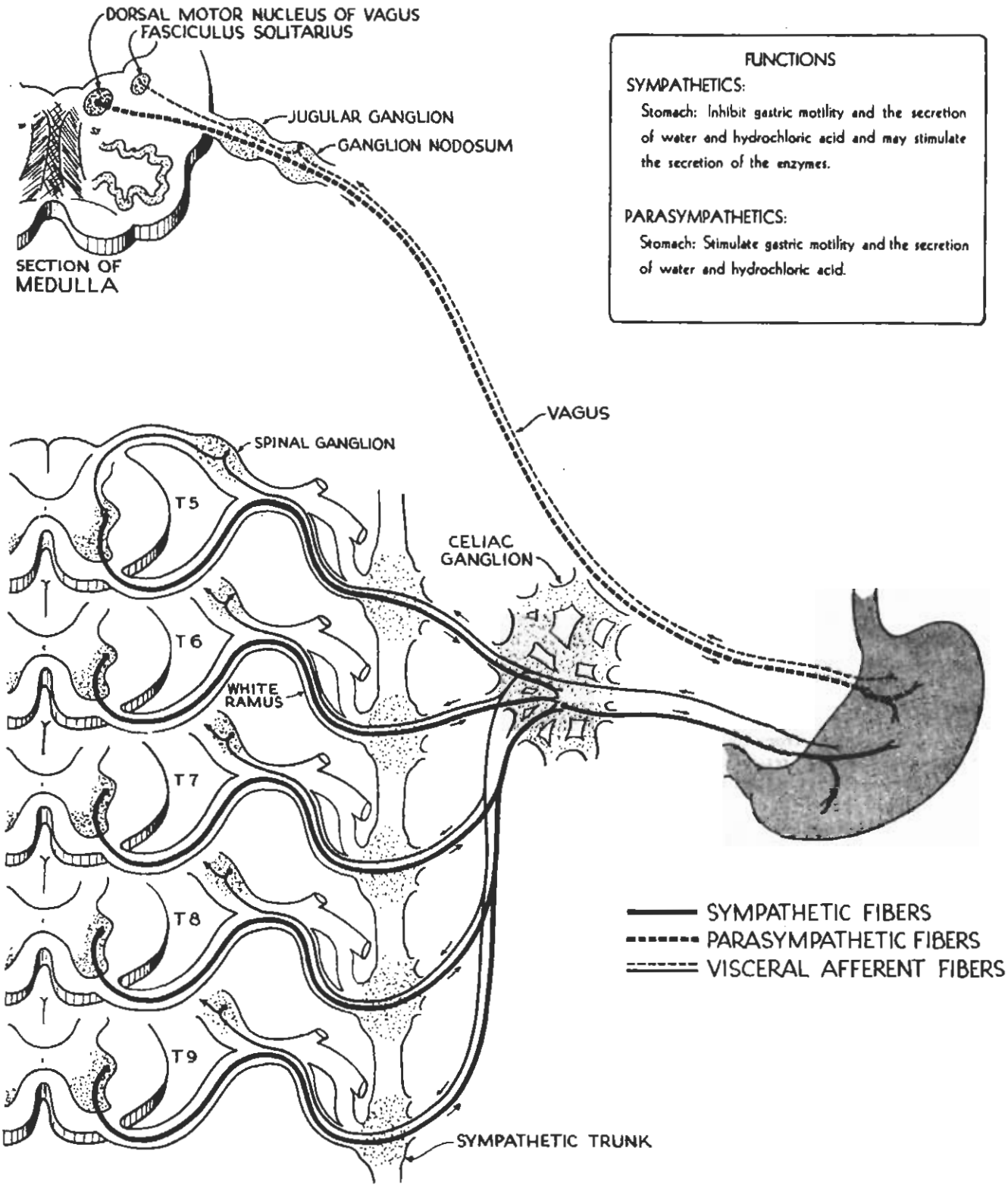
TREATMENT

1. Correct contributing and reflex etiological factors.
2. Inhibit vagal activity.
3. Correct inhibitive spinal lesions in the thoracic region and stimulate 5th to 9th thoracic nerves.

VISCERAL AND SOMATIC RESPONSES

When the stomach is involved in inflammation or is otherwise irritated, three responses or reflexes may be observed in visceral and somatic structures outside the stomach:

1. Other organs reached by the vagus may be stimulated reflexly and manifest changes in function characteristic of predominating parasympathetic activity and thus, there frequently may be observed the symptoms of esophageal spasm and hypermotility of the intestines causing spastic constipation or diarrhea.
2. Reflex muscular contraction involving the upper portion of the left rectus abdominis muscle and the spinal muscles in the region of the 5th to 9th thoracic vertebrae.
3. Pain referred to the skin and subcutaneous tissues of the epigastrium and the region over the 5th to 9th thoracic vertebrae.



THE INNERVATION OF THE STOMACH

6 ~ THE SMALL INTESTINE

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 5th to 12th thoracic nerves

Functions: Inhibit peristalsis, depress the activity of the secretory glands and constrict the intestinal blood vessels.

PARASYMPATHETIC: Vagus nerves

Functions: Stimulate peristalsis, increase the activity of the secretory glands and possibly dilate the intestinal blood vessels

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of the sympathetic supply* caused by irritative spinal lesions in the region of the 5th to 12th thoracic nerves; action of toxins associated with acute infections; psychic states as fear, anger, pain, worry, excitement, etc.; or certain endocrine disturbances causing sympathetic stimulation.
2. *Inhibition of parasympathetic (Vagus) supply* due possibly to upper cervical lesions.

POSSIBLE EFFECTS

Atonicity and hypomotility of the intestine and a reduction in the secretion from the intestinal glands leading to intestinal stasis and retarded intestinal digestion with a consequent fermentation and gas formation.

TREATMENT

1. Correct any existing irritative spinal lesions in the thoracic region and apply inhibition to the 5th to 12th thoracic nerves.
2. Stimulate parasympathetic (Vagal) activity.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. *Vagal stimulation* due reflexly to irritations within the small intestine or to inflammation or other irritation in other organs reached by parasympathetic nerves as in gastric ulcer, chronic appendicitis, inflammation of the gall bladder, gastritis, pulmonary tuberculosis, sinusitis, eye strain, etc.
2. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 5th to 12th thoracic nerves.

POSSIBLE EFFECTS

There may be either a hypermotility of the intestine involving chiefly the longitudinal muscles causing diarrhea or there may be a hypertonicity causing an uneven contraction of the circular muscles leading to a retarded movement of food masses with consequent fermentation and gas formation with gaseous distention.

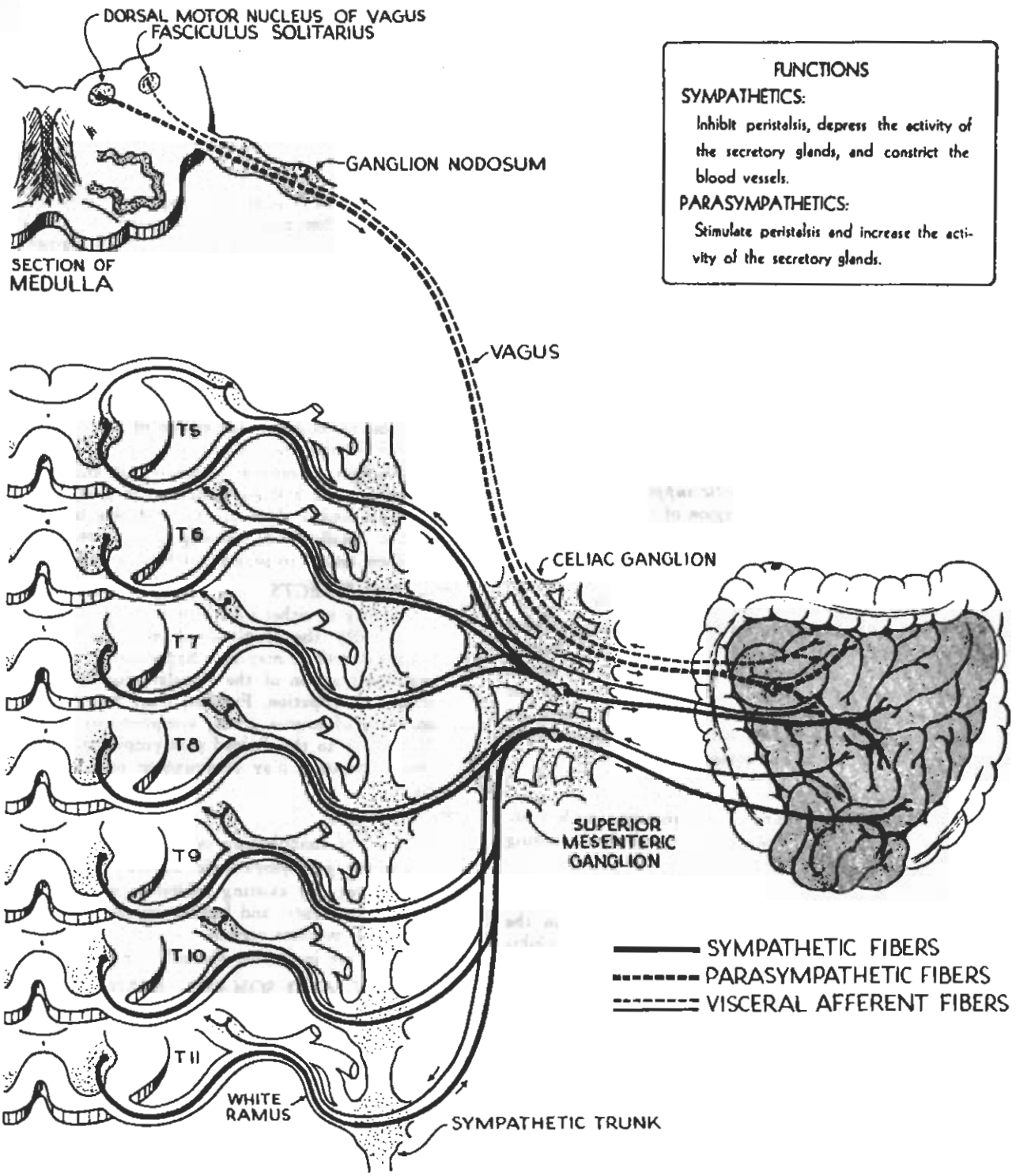
TREATMENT

1. Correct contributing and reflex etiological factors.
2. Inhibit vagal activity.
3. Correct inhibitive spinal lesions in the thoracic region and stimulate the 5th to 12th thoracic nerves.

VISCERAL AND SOMATIC RESPONSES

When the small intestine is involved in inflammation or is otherwise irritated, three responses or reflexes may be observed in visceral and somatic structures outside the intestine:

1. Other organs reached by the vagus may be stimulated reflexly and thus manifest changes in function characteristic of predominating parasympathetic activity and consequently there frequently may be observed the symptoms of gastric hypermotility, hyperchlorhydria and spasticity of the proximal half of the colon.
2. Reflex muscular contraction involving the 5th to 11th intercostal muscles, the rectus abdominis, transversalis, internal and external abdominal oblique and the psoas major and minor depending upon the portion of the small intestine involved.
3. Pain referred to the skin and subcutaneous tissue in the region centering around the umbilicus.



THE INNERVATION OF THE SMALL INTESTINE

7 ~ THE LARGE INTESTINE

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 11th thoracic to the 4th lumbar nerves

Functions: Inhibit peristalsis, contract the internal anal sphincter, depress the activity of the secretory glands and constrict the blood vessels

PARASYMPATHETIC: The vagus nerves to the proximal half of the colon and the sacral parasympathetics arising from the 2nd, 3rd and 4th sacral spinal segments to the distal half of the colon

Functions: Stimulate peristalsis, inhibit internal anal sphincter and increase the activity of the secretory glands

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of the sympathetic supply* caused by irritative spinal lesions in the region of the 11th thoracic to 4th lumbar nerves; action of toxins associated with acute infections; psychic states as fear, anger, pain, worry, excitement, etc.; or certain endocrine disturbances causing sympathetic stimulation.
2. *Inhibition of the parasympathetic supply* due to upper cervical or to lower lumbar or sacro-iliac lesions. When the vagus nerves are involved, disturbances in function may be observed in the proximal half of the colon. When the sacral parasympathetic fibers are involved, disturbances in function may be observed in the distal half of the colon.

POSSIBLE EFFECTS

Atonicity and hypomotility of the intestine with a reduction in the secretion from the intestinal glands causing an atonic constipation; tight anal sphincter.

TREATMENT

1. Correct any existing irritative spinal lesions in the lower thoracic and lumbar regions and apply inhibition to 11th thoracic to 4th lumbar nerves.
2. Stimulate parasympathetic supply—the vagus if the proximal half of the colon is involved or the sacral parasympathetics if the distal half is involved.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. *Parasympathetic stimulation* due reflexly to irritation within the colon or to inflammation or other irritation in organs reached by other branches of the parasympathetic nerves which supply the colon. By this means, predominating parasympathetic activity in the colon may be due to sinusitis, eye strain, nontoxic pulmonary affections, peptic ulcer, gastritis, inflammation of the gall bladder or appendix, cystitis, prostatitis, urethritis, cervicitis, vaginitis or other urogenital irritation.
2. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 11th thoracic to 4th lumbar nerves.
3. *Changes in cellular chemistry* of the tissues of the colon with a relative increase in potassium over calcium and a shift of the acid-base balance towards the alkaline side causing greater responsiveness of these tissues to parasympathetic impulses.

POSSIBLE EFFECTS

There may be either a hypermotility of the colon involving chiefly the longitudinal muscles and thus cause diarrhea or there may be a hypertonicity causing an uneven contraction of the circular muscles with resulting spastic constipation. Further, there may be an increased secretion of mucus giving symptoms of mucous colitis. Note: Due to the divided parasympathetic nerve supply, these symptoms may be found in only one-half of the colon.

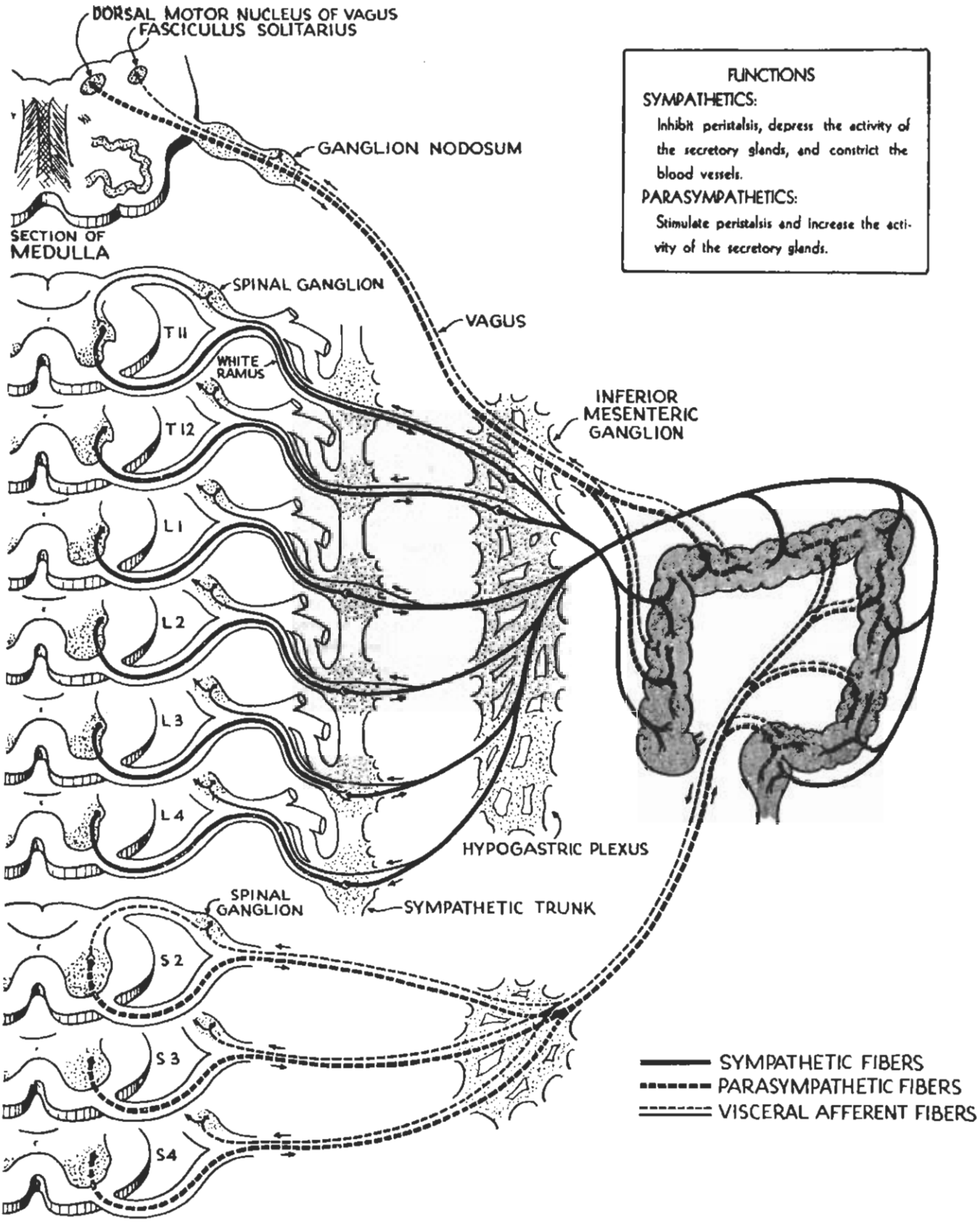
TREATMENT

1. Correct contributing or reflex etiological factors.
2. Inhibit parasympathetic nerves.
3. Correct any existing inhibitive spinal lesions in the lower thoracic and lumbar regions and stimulate the nerves in these regions.
4. Consider increasing the calcium intake.

VISCERAL AND SOMATIC RESPONSES

When the large intestine is involved in inflammation or is otherwise irritated, three responses or reflexes may be observed in somatic and other visceral structures:

1. Other organs reached by parasympathetic fibers may be stimulated reflexly and thus manifest changes in function characteristic of predominating parasympathetic activity and consequently there frequently may be observed the symptoms of sinusitis, rhinitis, asthma, hyperchlorhydria, and hypermotility of the stomach and small intestine.
2. Reflex muscular contraction involving the psoas major and minor and the lower portions of the rectus abdominis, transversalis and the internal and external abdominal oblique muscles.
3. Pain may be referred to the skin and subcutaneous tissue in the lower right and left quadrants of the abdomen.



THE INNERVATION OF THE LARGE INTESTINE

8 ~ THE PANCREAS

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 5th to 9th thoracic nerves

Functions: Decrease secretion of pancreatic juice

PARASYMPATHETIC: Vagus nerves

Functions: Stimulate secretion of pancreatic juice. The secretion of insulin probably is little influenced by the nervous mechanism but there is some evidence that parasympathetic impulses may augment the output of insulin

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. ***Stimulation of the sympathetic supply*** caused by irritative spinal lesions in the region of the 5th to 9th thoracic nerves; action of toxins associated with acute infections; psychic states as fear, anger, worry, pain, excitement, etc.; or certain endocrine disturbances which cause general sympathetic stimulation.
2. ***Inhibition of the parasympathetic (Vagus) supply*** due possibly to upper cervical lesions.

POSSIBLE EFFECTS

Decrease in the production of pancreatic juice with resulting impairment of digestion.

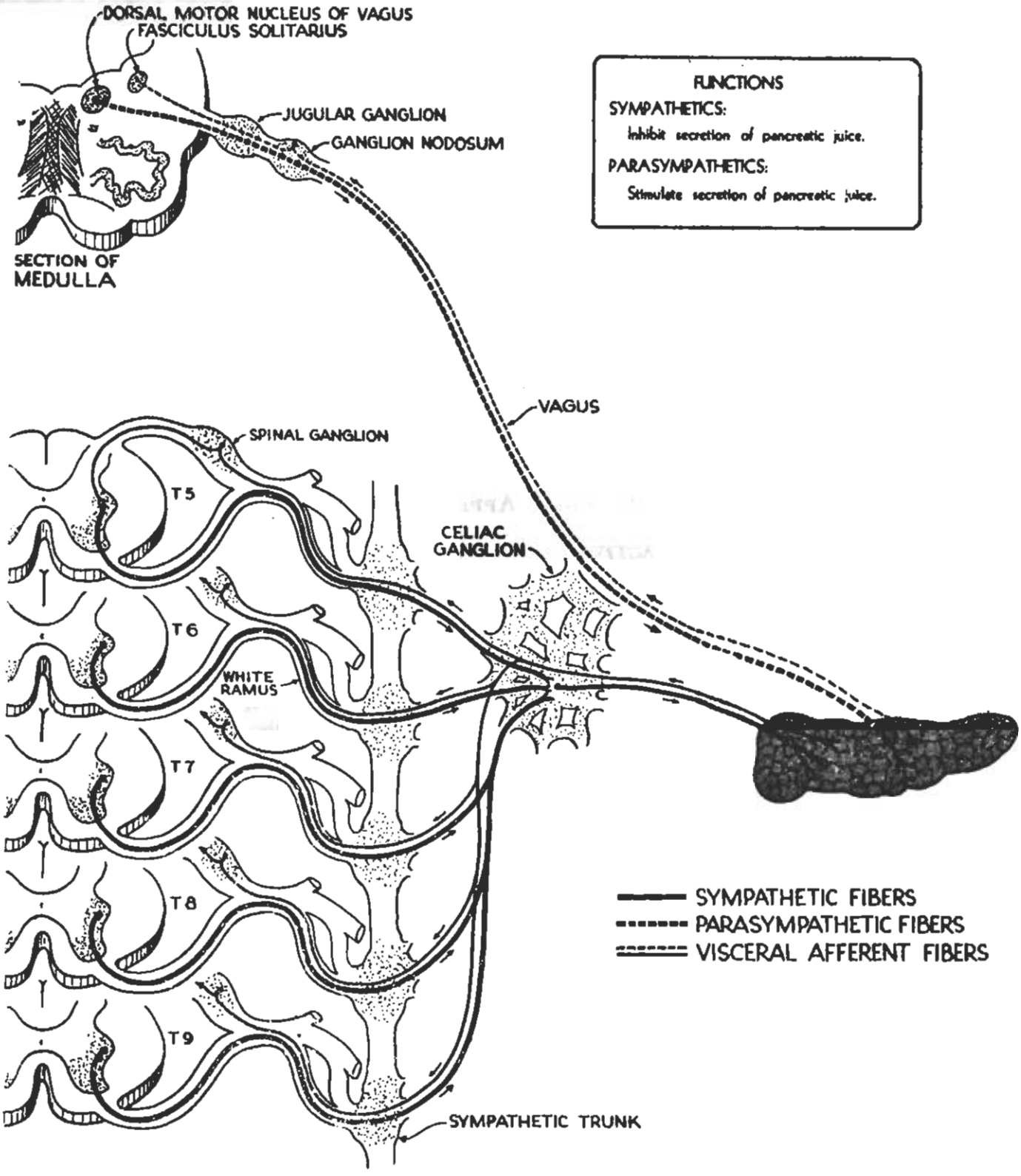
TREATMENT

1. Correct any existing irritative spinal lesions in the thoracic area and apply inhibition to the 5th to 9th thoracic nerves.
2. Stimulate parasympathetic (Vagal) activity.

VISCERAL AND SOMATIC RESPONSES

When the pancreas is involved in inflammation, three responses or reflexes may be observed in visceral or somatic structures outside the pancreas:

1. Other organs reached by the vagus may be stimulated reflexly and manifest changes in function characteristic of predominating parasympathetic activity and thus, there frequently may be observed the symptoms of hyperchlorhydria, hypermotility of the stomach, and hypermotility and hypersecretion of the intestines causing spastic constipation or diarrhea.
2. Reflex muscular contraction involving the upper portion of the left rectus abdominis muscle and the spinal muscles in the region of the 5th to 9th thoracic vertebrae.
3. Pain referred to the skin and subcutaneous tissues over the upper part of the left rectus abdominis muscle.



THE INNERVATION OF THE PANCREAS

9 ~ THE LIVER AND GALL BLADDER

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 5th to 9th thoracic nerves

Functions: Sympathetic impulses to the liver exert a vasomotor control, facilitate the conversion of glycogen into glucose, increase the protein metabolism within the liver, and inhibit the cholesterol secretion in the bile. Sympathetic impulses to the gall bladder tend to relax the muscles of the gall bladder and constrict the sphincters of the bile ducts

PARASYMPATHETIC: Vagus nerves

Functions: Parasympathetic impulses to the liver inhibit the protein metabolism within the liver and increase the secretion of cholesterol in the bile. Parasympathetic impulses to the gall bladder contract the muscles of the bladder wall

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. ***Sympathetic stimulation*** caused by irritative spinal lesions in the region of the 5th to 9th thoracic nerves or factors which cause a general sympathetic stimulation.
2. ***Inhibition of the parasympathetic (Vagal) supply*** due possibly to upper cervical lesions.

POSSIBLE EFFECTS

Faulty emptying of the gall bladder and therehy possibly predisposing to the formation of gall stones.

TREATMENT

1. Correct any existing irritative spinal lesions in the thoracic region and apply inhibition to the 5th to 9th thoracic nerves.
2. Stimulate parasympathetic (Vagal) activity.

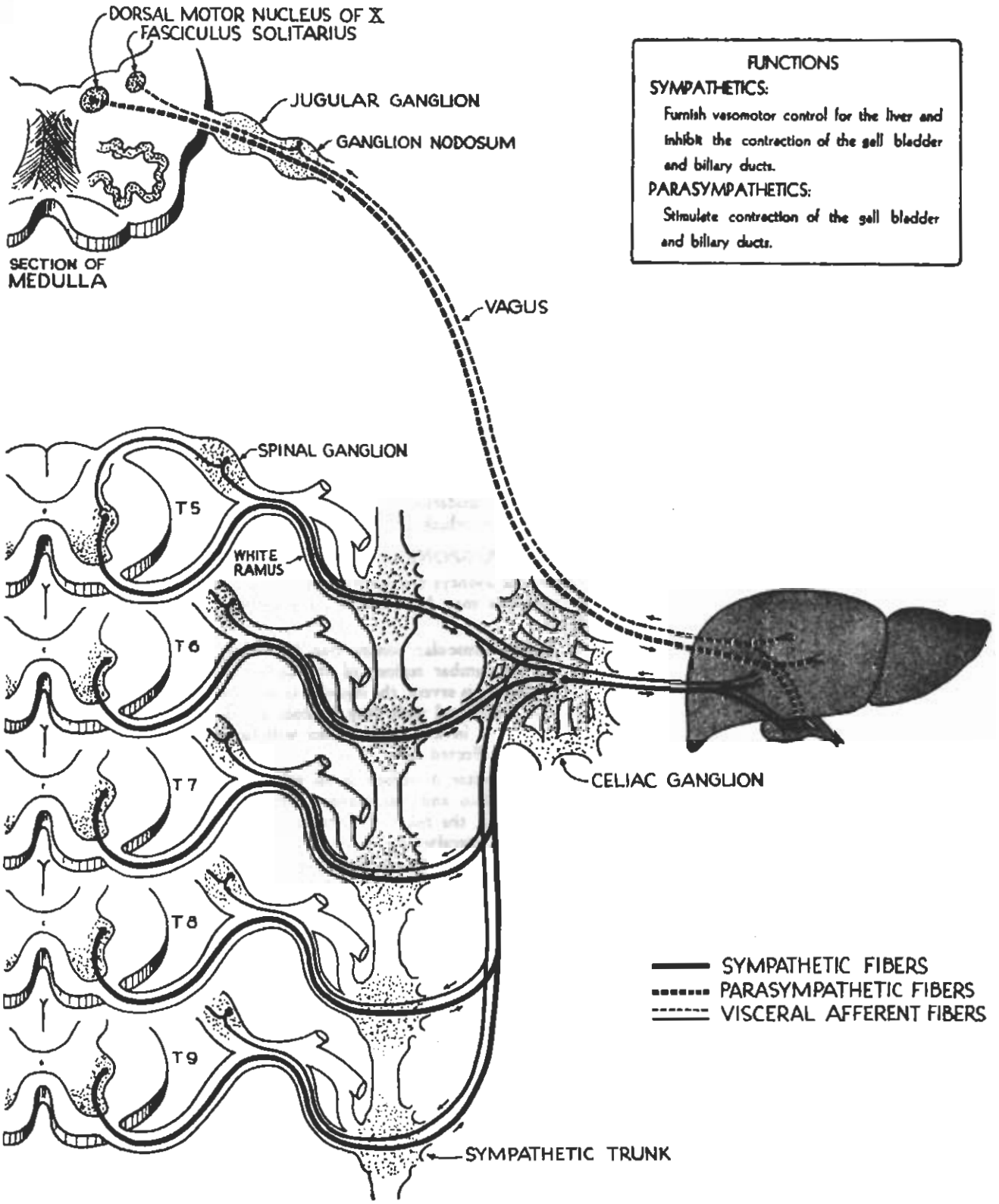
PREDOMINATING PARASYMPATHETIC ACTIVITY

No clearly recognized functional disturbance has been recognized as arising from predominating parasympathetic activity in the liver or gall bladder.

VISCERAL AND SOMATIC RESPONSES

When the liver or gall bladder are involved in a pathological process, three responses or reflexes may be observed in visceral and somatic structures outside the liver and gall bladder:

1. Parasympathetic reflexes are expressed in other organs reached by the vagus nerves and thus overactivity of the parasympathetic functions may be observed in other organs and manifest as esophageal spasm, cardiospasm, hyperchlorhydria, gastric and intestinal hypermotility leading to diarrhea or spastic constipation with colicky pains and intestinal stasis.
2. Reflex muscular contraction involving the upper portion of the right rectus abdominis muscle.
3. Pain may be referred to the skin and subcutaneous tissues of the epigastrium and extending to the right to the costal margin. In addition, pain may be referred to an area to the right of the 5th to 9th thoracic vertebrae. In cases of liver disease, there may be another reflex expressed via the phrenic nerve and pain may be referred to the right shoulder area.



THE INNERVATION OF THE LIVER AND GALL BLADDER

10 ~ THE KIDNEYS

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 10th, 11th, and 12th thoracic nerves

Functions: Exert vasomotor control

PARASYMPATHETIC: Vagus nerves

Functions: Indefinite

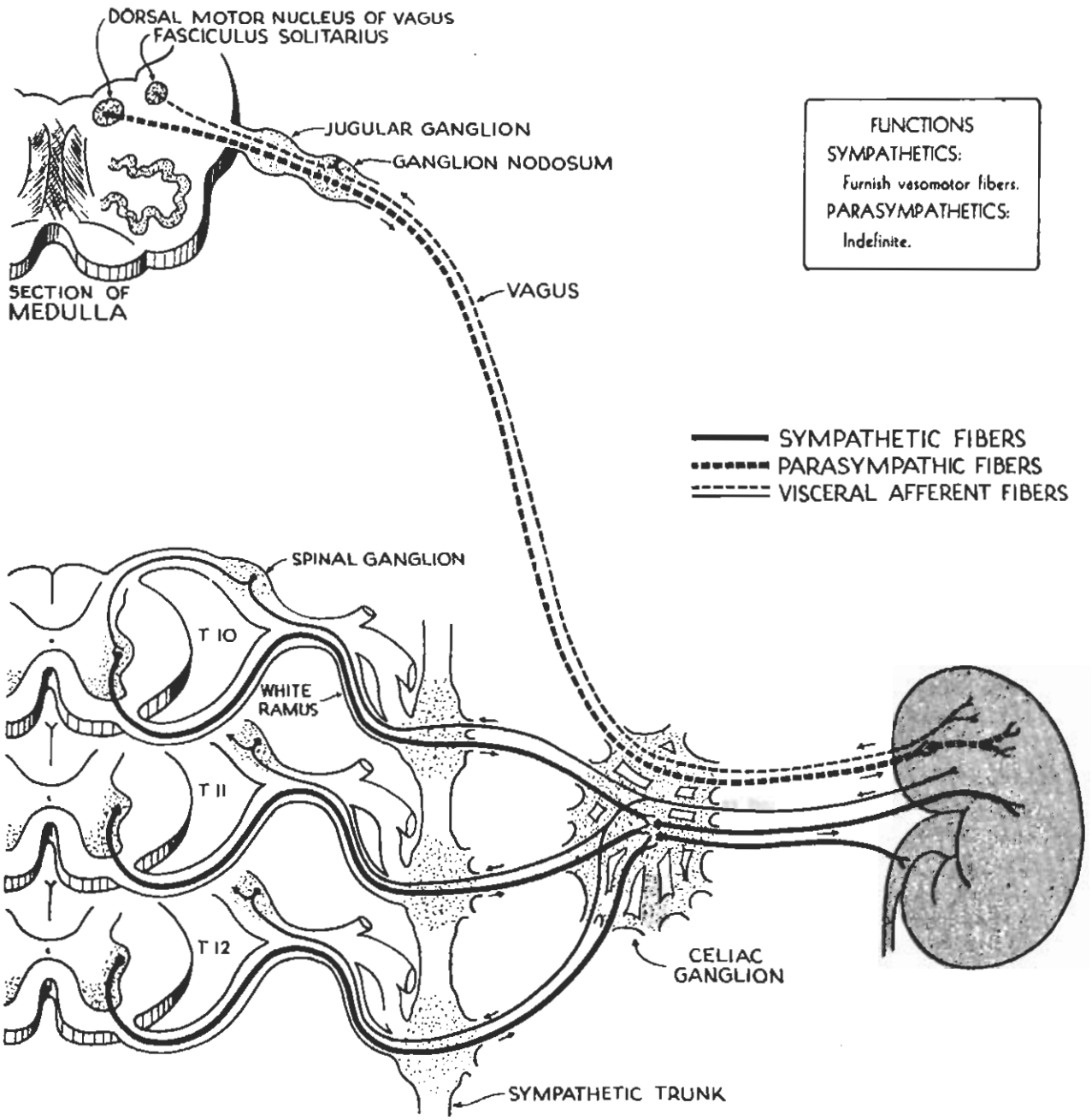
Clinical Application

The results, if any, of autonomic imbalance in the case of the kidneys are not clearly demonstrated and consequently little understood. Clinically important, however, are the reflexes which occur in disease of the kidneys.

SOMATIC RESPONSES

When the kidneys are involved in a pathological process, two responses may be observed in structures outside the kidneys:

1. Reflex muscular contraction involving the muscles of the lumbar regions of the back and if the renal irritation is severe, the muscles in the lower portion of the abdominal wall may be contracted. If only one kidney is involved, the reflex will be expressed only on the affected side.
2. Pain (better described as an ache) may be referred to the skin and subcutaneous tissues of the lumbar region. If the renal iritation is severe, the pain may extend lateralward over the sides of the hips, the lower part of the anterior abdominal wall and into the scrotum.



THE INNERVATION OF THE KIDNEYS

11 ~ THE URINARY BLADDER

Innervation

SYMPATHETIC: Sympathetic visceral branches from the first three or four lumbar nerves

Functions: Excite contraction of the musculature in the trigonal region, of the internal sphincter and the urethra and tend to relax the musculature of the body of the bladder thus tending to retain the urine in the bladder

PARASYMPATHETIC: Parasympathetic visceral branches from the 2nd, 3rd and 4th sacral nerves.

Functions: Excite contraction of the musculature of the body of the bladder and tend to relax the musculature of the trigonal region, the internal sphincter and the urethra thus tending to empty the bladder

Clinical Application

PREDOMINATING SYMPATHETIC ACTIVITY

ETIOLOGY

1. *Stimulation of the sympathetic supply* caused by irritative spinal lesions in the region of the 1st to 4th lumbar nerves; factors which cause a general sympathetic stimulation.
2. *Inhibition of the parasympathetic supply* due possibly to mechanical lesions.

POSSIBLE EFFECTS

Interference with the micturition reflex with difficulty in urination; in severe cases, perhaps, a retention of urine.

TREATMENT

1. Correct any existing irritative spinal lesions in the lumbar region and apply inhibition to the 1st to 4th lumbar nerves.
2. Stimulate the sacral parasympathetic nerves.

PREDOMINATING PARASYMPATHETIC ACTIVITY

ETIOLOGY

1. *Parasympathetic stimulation* due reflexly to irritations in the bladder or in other organs reached by sacral parasympathetic nerves such as irritation or inflammation involving the distal half of the colon, the rectum, anal canal, uterus, vagina or external genitalia.
2. *Underactivity of the sympathetic supply* due to inhibitive lesions in the region of the 1st to 4th lumbar nerves.

POSSIBLE EFFECTS

Increased bladder irritability with frequent urination and in severe cases, perhaps urinary incontinence.

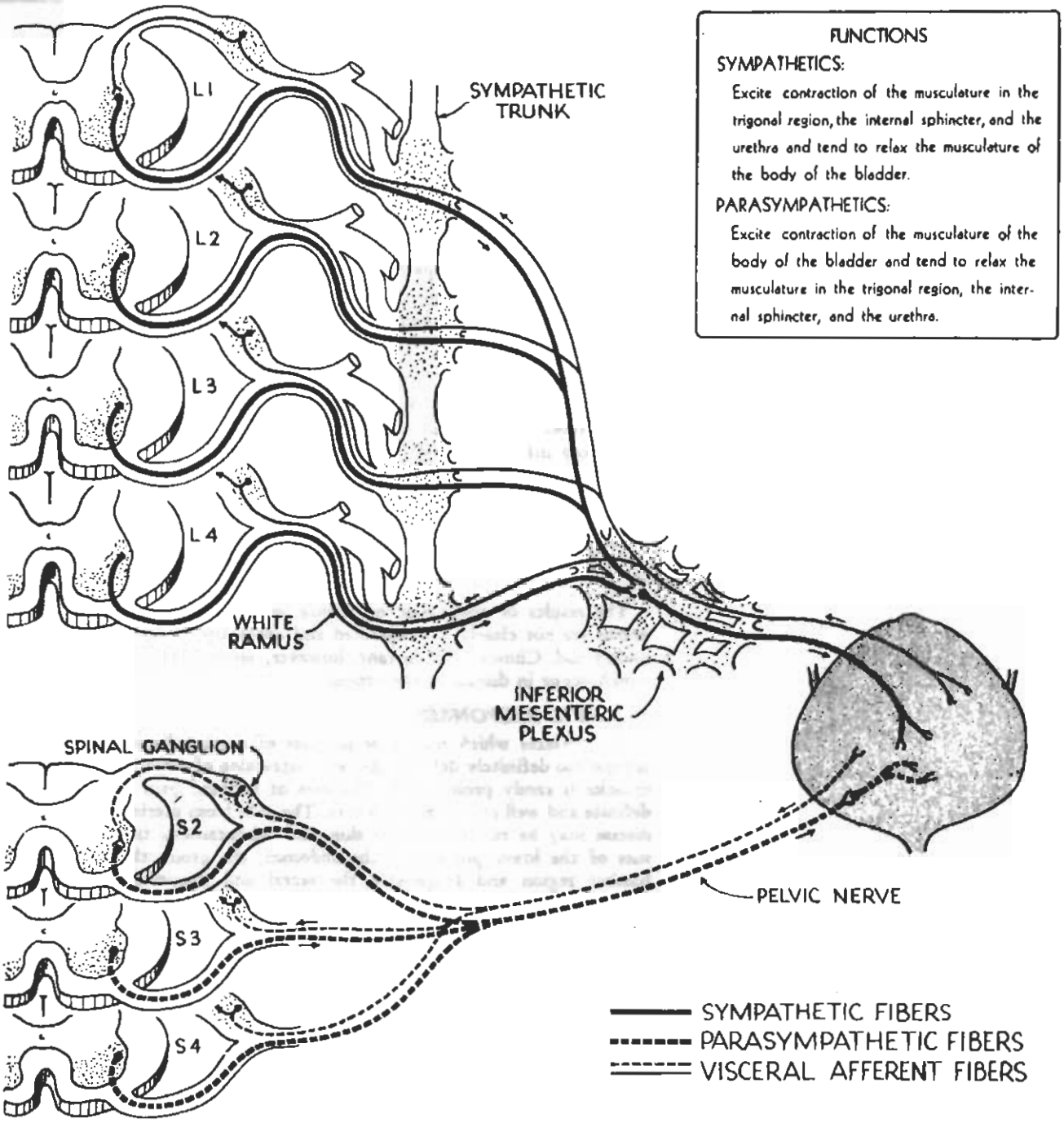
TREATMENT

1. Correct contributing and reflex etiological factors.
2. Inhibit parasympathetic activity.
3. Correct inhibitive spinal lesions in the lumbar region and stimulate the first four lumbar nerves.

VISCERAL AND SOMATIC RESPONSES

When the urinary bladder is inflamed or is otherwise irritated, three responses may be observed in visceral and somatic structures outside the bladder:

1. Other organs reached by sacral parasympathetic nerves may be reflexly stimulated and manifest changes in function characteristic of predominating parasympathetic activity and thus there may occur such symptoms as spastic constipation or diarrhea.
2. Reflex muscular contraction involving the lower parts of the rectus abdominis muscles.
3. Pain referred to the skin and subcutaneous tissues in the region above the pubis, over the sacrum and of the perineum.


FUNCTIONS
SYMPATHETICS:
Excite contraction of the musculature in the trigonal region, the internal sphincter, and the urethra and tend to relax the musculature of the body of the bladder.
PARASYMPATHETICS:
Excite contraction of the musculature of the body of the bladder and tend to relax the musculature in the trigonal region, the internal sphincter, and the urethra.
L1
L2
L3
L4
SYMPATHETIC TRUNK
WHITE RAMUS
INFERIOR MESENTERIC PLEXUS
SPINAL GANGLION
S2
S3
S4
PELVIC NERVE
SYMPATHETIC FIBERS
PARASYMPATHETIC FIBERS
VISCERAL AFFERENT FIBERS

THE INNERVATION OF THE URINARY BLADDER

12 ~ THE UTERUS

Innervation

SYMPATHETIC: Sympathetic visceral branches from the 11th thoracic to 4th lumbar nerves

Functions: Stimulate contraction of the muscles of the Fallopian tubes and uterus

PARASYMPATHETIC: Parasympathetic visceral branches from the 2nd, 3rd and 4th sacral nerves

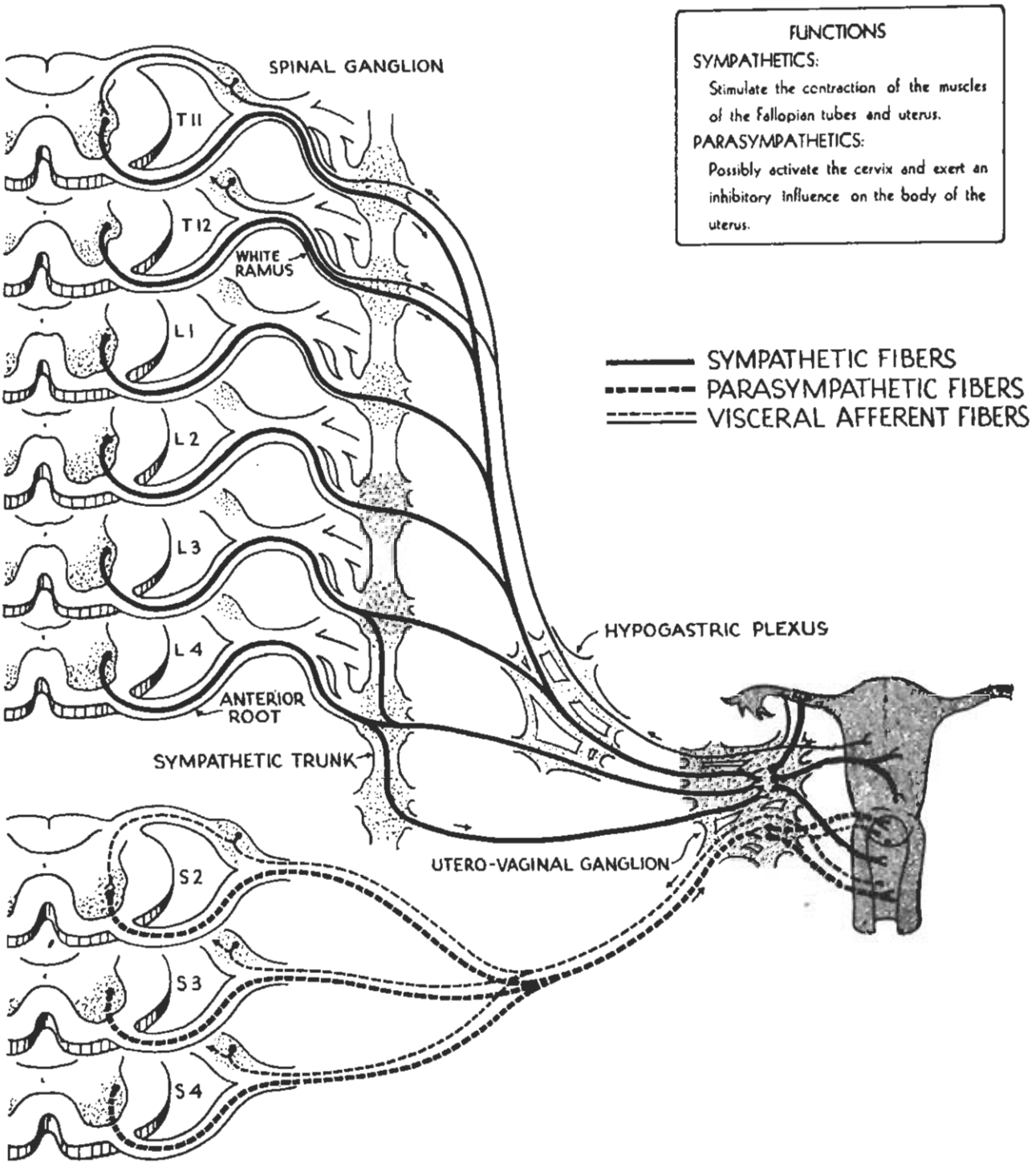
Functions: Possibly activate the cervix and exert an inhibitory influence on the body of the uterus

Clinical Application

The results of autonomic imbalance in the case of the uterus are not clearly demonstrated and consequently little understood. Clinically important, however, are the reflexes which occur in disease of the uterus.

SOMATIC RESPONSES

The reflexes which may arise in cases of uterine disease are not too definitely defined. Reflex contraction of somatic muscles is rarely pronounced. The area of referred pain is definite and well recognized however. The pain from uterine disease may be referred to the skin and subcutaneous tissues of the lower portion of the abdomen, the groin, the lumbar region and frequently the sacral and mammary regions.



THE INNERVATION OF THE UTERUS

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